
Introgression of shoot fly resistance and post-flowering drought tolerance QTLs into post-rainy season sorghum elite varieties through Marker Assisted Backcross Breeding (MABB)

131. Dr. Vijaya Kumar KV



1. Introduction: Production constraints of Sorghum

- Sorghum is a **fifth** most important cereal crop in the world providing **food, fodder/forage** and **bio-fuel** in dryland agriculture
- In India, sorghum is grown during **rainy (Kharif)** and **post-rainy (rabi)** seasons
- The post-rainy sorghum crop in India is grown on **residual moisture** and inadvertently faces **terminal drought** with low productivity
- Quality requirements for both **Grain** and **Stover for livestock** are most stringent for **rabi** sorghum
- Stay green, the most widely studied post-flowering drought tolerance mechanism, contribute to drought tolerance and fodder quality



1. Introduction cont....

- **Shoot fly** is also a major **biotic stress** on post-rainy season sorghum
- Variable crop (grain production) loss (from about **50%** to **90%**) depending on shoot fly population pressure reported
- **Host Plant Resistance** coupled with timely sowing (onset of monsoon rains) is the best strategy to surmount additional **cost of production** and **hazardous effect** on the soil and environment
- To address these issues we undertook **MABB** program to introgress already *mapped and validated* **two stay-green QTLs** and **two shoot fly resistance QTLs** in **six elite post-rainy season cultivars**



2. Key component traits

Shoot fly resistance

- ✓ *Glossiness*
- ✓ *Trichome upper and lower leaf*
- ✓ Oviposition incidence (%)
- ✓ Dead heart incidence (%)
- ✓ Plant vigour
- ✓ Leaf sheath pigmentation
- ✓ Biochemical traits
(Zn, Tannin, Phenol, Cu, Mg, Fe,)

Post-flowering drought tolerance

- ✓ Green leaf area at booting (%)
- ✓ Green leaf area at maturity (%)
- ✓ % Green leaf area retained at maturity
- ✓ Leaf Canopy and architecture
- ✓ Rate of leaf senescence
- ✓ *Transpiration Efficiency*
- ✓ *Water Use Traits (pattern, volumes)*
- ✓ Root architecture (water extraction capacity)

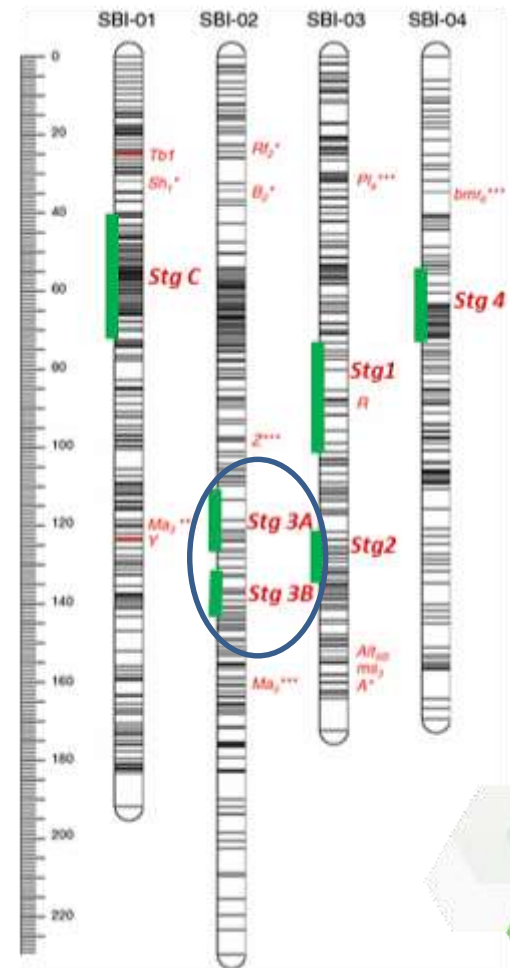
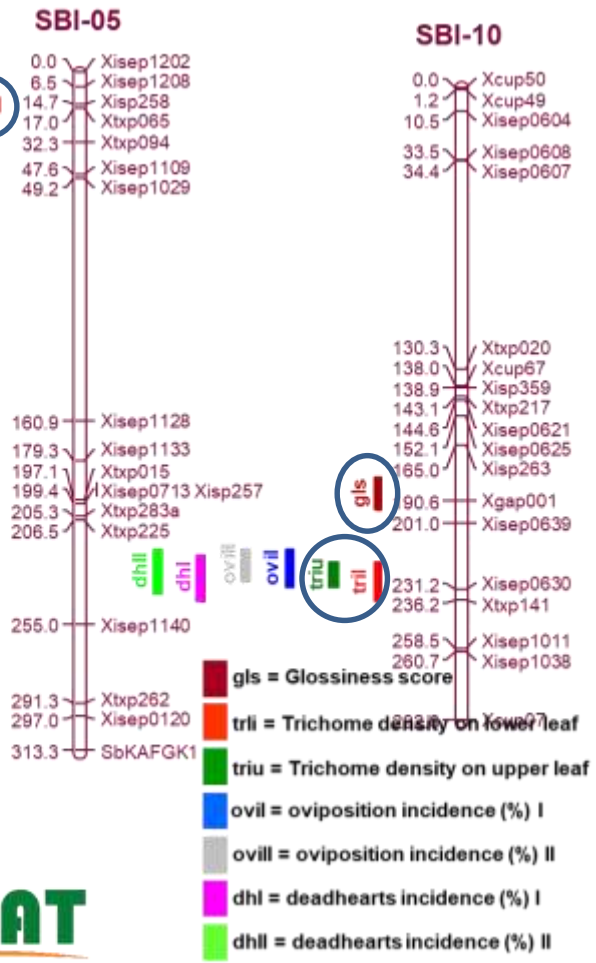


Shoot fly resistance QTLs

Post-flowering drought tolerance QTLs

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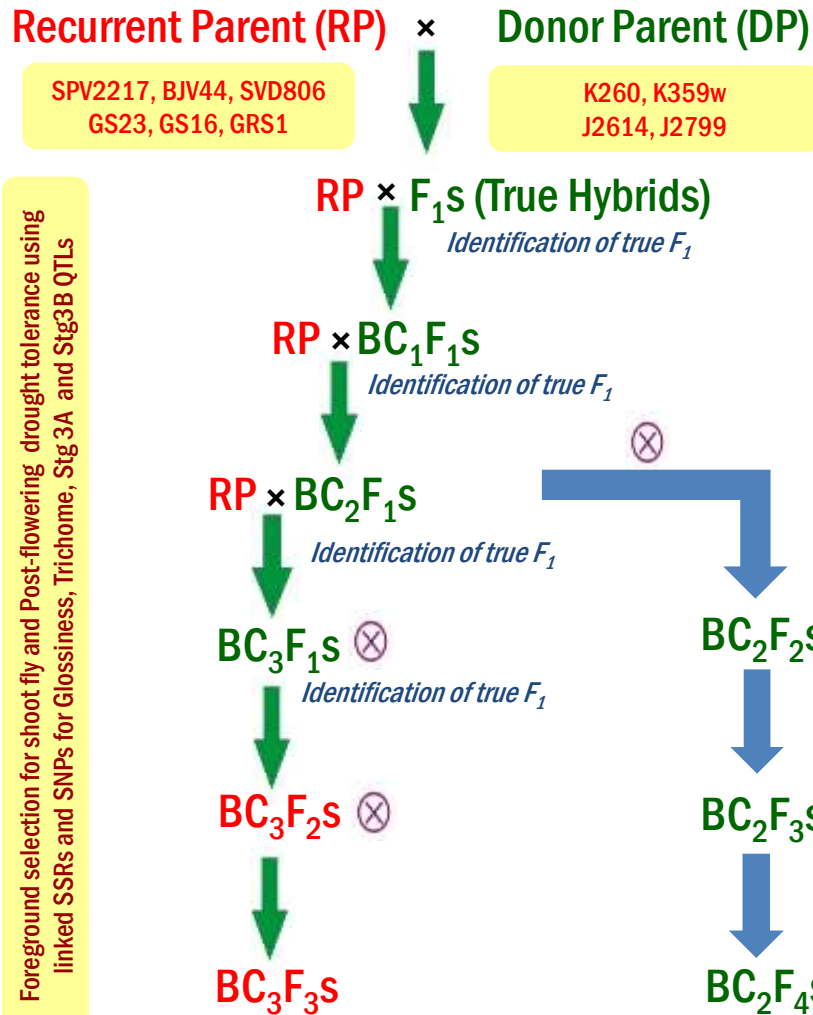
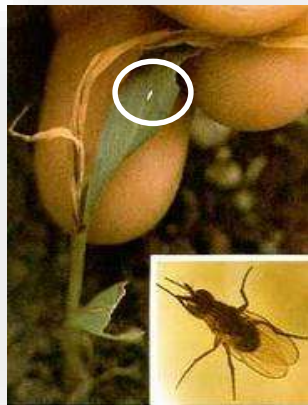
4. Genotypes targeted for Marker Assisted Back-Crossing of QTLs for shoot fly resistance and post-flowering drought tolerance

S. No	Institute	Recipient or donor parent	Target trait	Genotype names
1	University of Agricultural Sciences - Dharwad	Recipient	Shoot fly resistance; and Post-flowering drought tolerance	SPV2217, BJV44 and SVD806
2	University of Agricultural Sciences – Raichur	Recipient	Shoot fly resistance; and Post-flowering drought tolerance	GS23, GS16 and GRS1 (DSV5)
3	ICRISAT	Donor	Shoot fly resistance	J2614-5 (glossiness QTL), J2799 (trichome QTL)
		Donor	Post-flowering drought tolerance	K260 (stg3A QTL), K359W (stg3B QTL)



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B

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Staggered Sowing



Donors and recipients for MABC of stay-green and shoot fly resistance



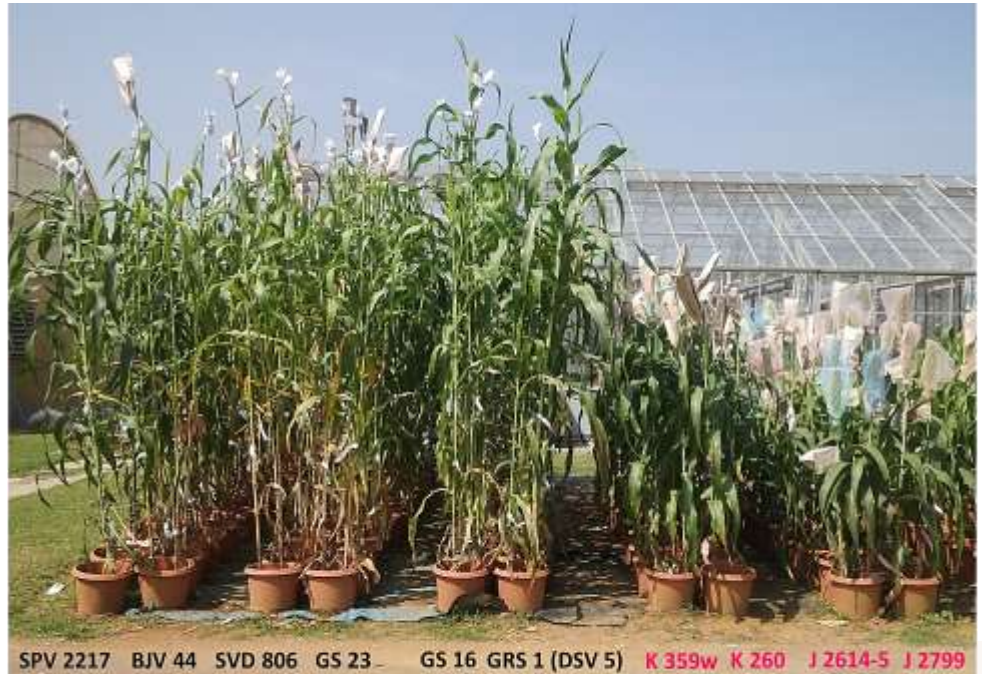
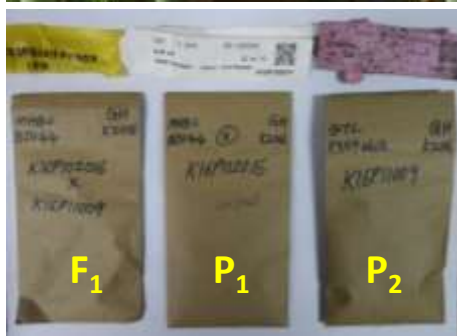
MABC Staggered Sowing of donors and recipients



Plant × Plant crossing and selfing activity



Color tags and maintaining seed lots/pockets through generations



Recurrent Parents

Donor Parents



5. SNPs development

Trait	QTL targeted	Linkage group	Interval start (bp)	Interval end (bp)	Interval (bp)
Post- flowering drought tolerance	K260 (stg3A QTL)	SBI-02	56,112,177	61,953,206	5,841,029
	K359W (stg3B QTL)	SBI-02	69,739,036	71,419,274	1,680,238

Trait	QTL targeted	Linkage group	Interval start (bp)	Interval end (bp)	Interval (bp)
Shoot fly resistance	J2614-5 (glossiness QTL)	SBI-05	0,638,420	4,275,229	3,636,809
	J2799 (trichome QTL)	SBI-07	0,451,705	5,118,505	4,666,800
		SBI-10	56,573,616	61,076,101	4,502,485

- **Filtered SNPs** for – missing calls, Downstream, Upstream, Intron, Intergenic region and low coverage synonymous SNPs including SNPs falling in splicing region



SNP and SSRs utilized for MABC program

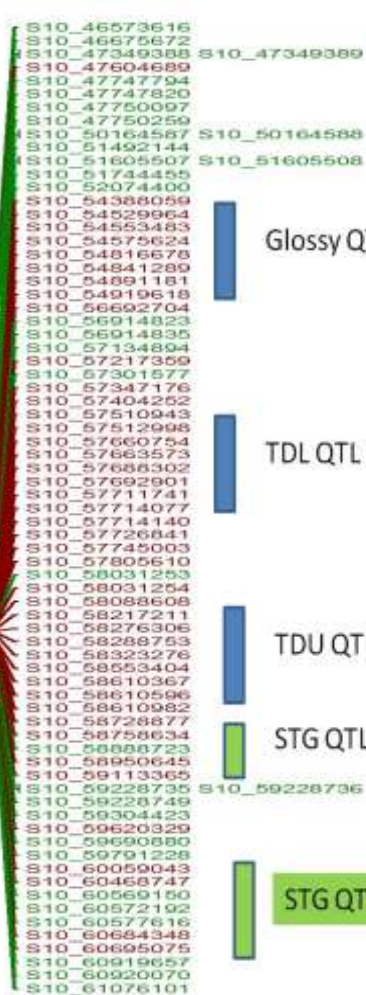
SBI-02

Stg 3A

Stg 3B



SBI-10



Glossy QTL region

TDL QTL region

TDU QTL region

STG QTL region

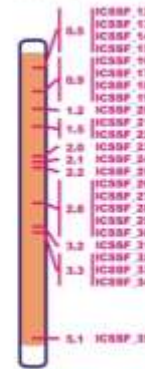
STG QTL region

SBI-05



● SSR markers in genomic regions for Short-By-Resistance Composed traits
● Polymorphic SNPs

SBI-07



● Polymorphic SNPs

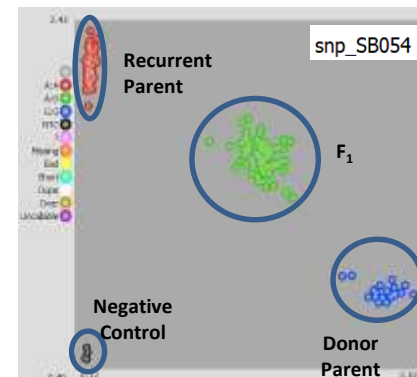
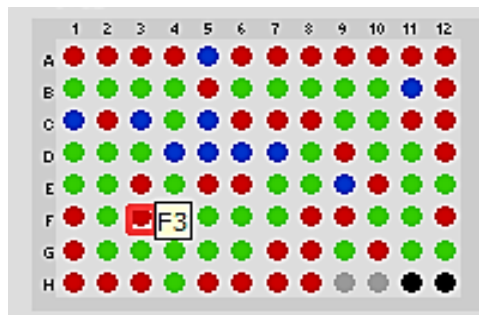
QTL region for glossy

QTL region for trichome

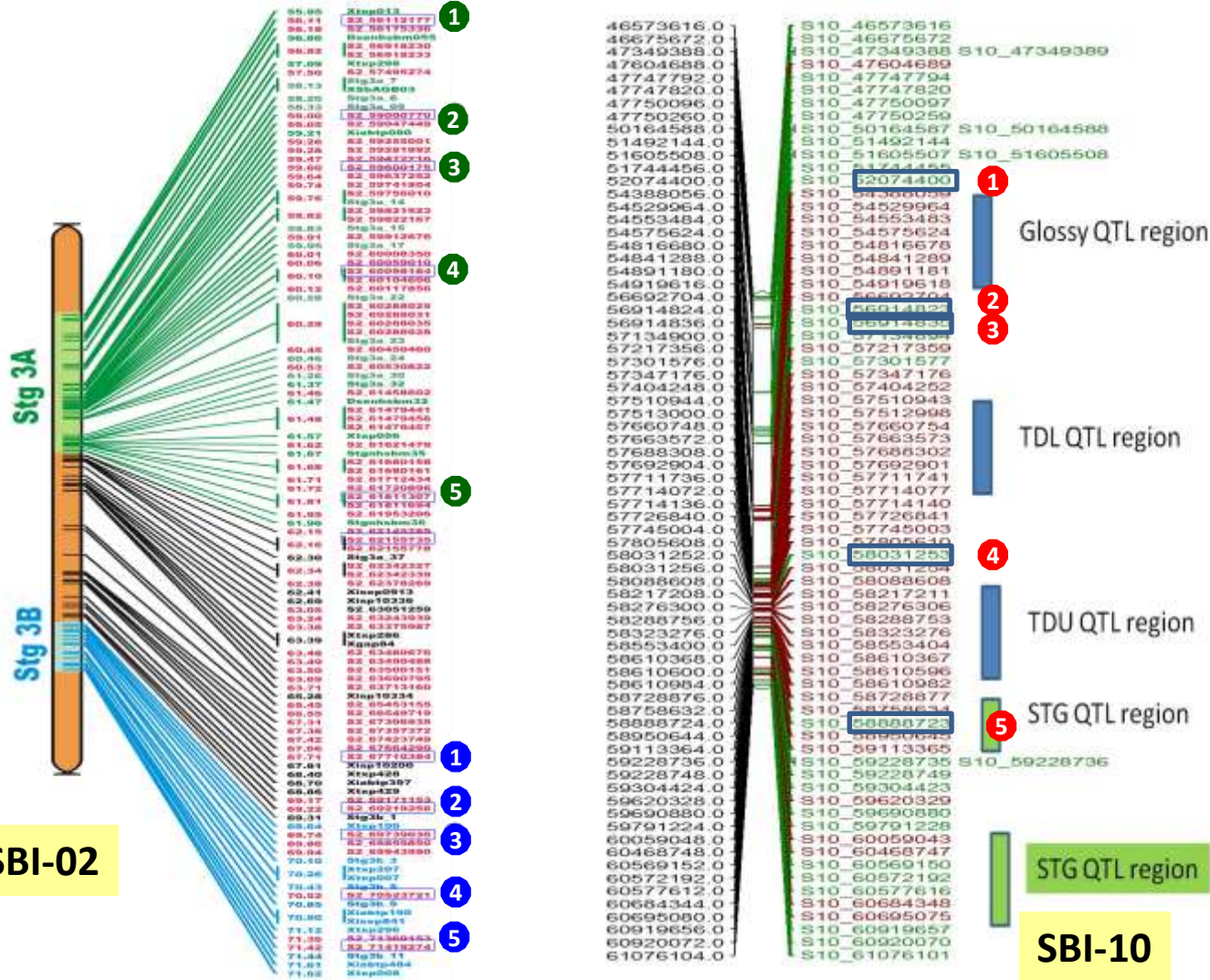


Assessment of efficient SNPs on diverse 96 panel (Recurrent and donor parents, F₁s, BCnF₁s and F₂s) by LGCTTM KASPar SNP assay

Trait	QTL targeted for MABC	No. of SNPs evaluated	No. of Polymorphic SNPs (10)	Differentiating F ₁ s (40)	Segregating in F ₂ families (6)
Post- flowering Drought tolerance	K260 (Stg 3A QTL)	69	26	15	12
	K359w (Stg 3B QTL)		4	3	3
Shoot fly resistance	J2614-5 (glossiness QTL)	68	23	21	20
	J2799 (trichome QTL)		10	12	8



Shortlisted SNPs for MABC program



Parental polymorphism for post-flowering drought tolerance and shoot fly resistance using SNP and SSR markers

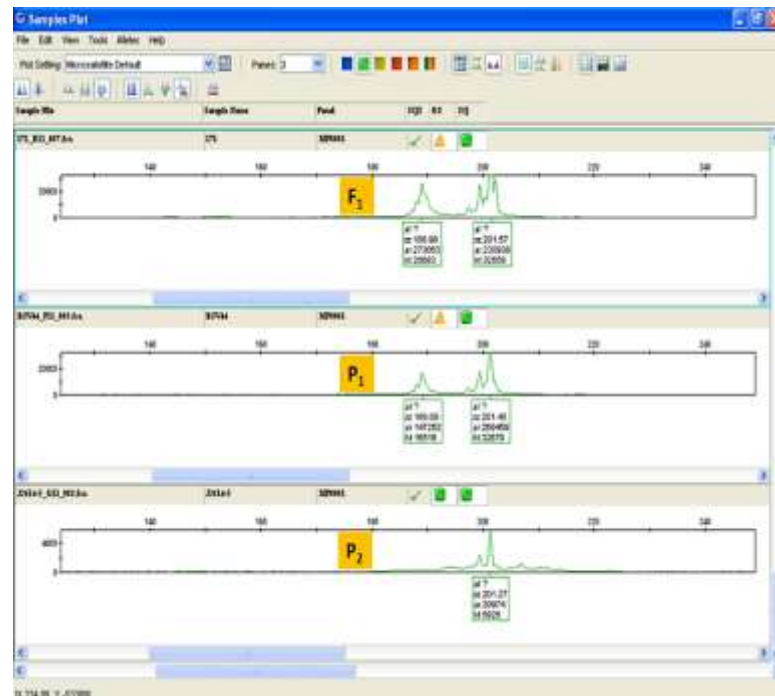
Traits	QTL targeted for MABC	Number of SSR markers attempted	Polymorphic SSR markers
Post-flowering drought tolerance	K260 (Stg 3A QTL)	46	8
	K359w (Stg 3B QTL)		8
Shoot fly resistance	J2614-5 (glossiness QTL)	52	15
	J2799 (trichome QTL)		19



Details of crossed materials utilized for hybridity confirmation at UAS-Dharwad and UAS-Raichur

Traits	UAS Dharwad			UAS Raichur	
	Crosses	Set-1*	Set-2*	Crosses	Set-1*
Post- flowering drought tolerance	SPV 2217 × K 359w	18/32	0/2	GS 23 × K 359w	11/15
	BJV 44 × K 359w	10/19	14/42	GRS 1 × K 359w	5/12
	SVD 806 × K 359w	8/13	17/27	GS 15-10 × K 359w	0/5
	SPV 2217 × K 260	5/14	4/31	GS 23 × K 260	7/12
	BJV 44 × K 260	3/14	24/44	GRS 1 × K 260	3/16
	SVD 806 × K 260	2/22	14/60	GS 15-10 × K 260	4/8
	Total	119/320			30/68
Shootfly resistance	SPV 2217 × J2614-5	0/46	3/11	GS 23 × J2614-5	19/22
	BJV 44 × J2614-5	14/18	1/36	GRS 1 × J2614-5	1/16
	SVD 806 × J2614-5	15/26	28/38	GS 15-10 × J2614-5	0/9
	SPV 2217 × J2799	15/24	10/22	GS 23 × J2799	4/10
	BJV 44 × J2799	0/10	32/40	GRS 1 × J2799	10/13
	SVD 806 × J2799	2/2	8/8	GS 15-10 × J2799	4/10
	Total	148/281			38/80

*Number of true F₁s confirmed through SSR markers over total number of plants subjected for F₁ confirmation

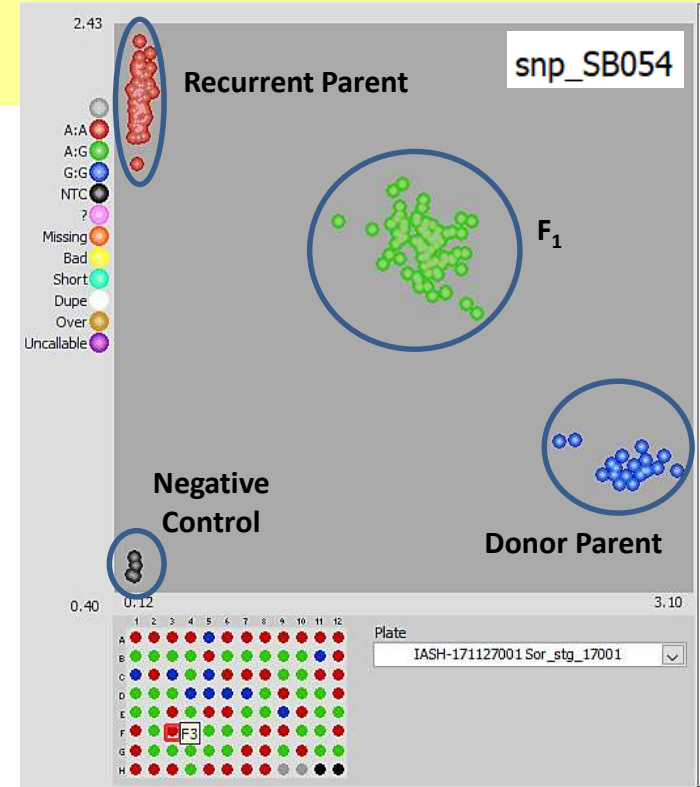


The genotypes plot window displays an electropherogram for each selected marker



LGC™ -KASPar assay of BC₁F₁s from UAS Dharwad using 14 SNPs markers for post flowering drought tolerance

Cross No.	Pedigree	BC ₁ F ₁ Confirmed
C1	(SPV-2217 × K-359) × SPV-2217	32/82
C2	(BJV-44 × K-359) × BJV-44	47/64
C3	(SVD-803 × K-359) × SVD-803	27/37
C4	(SPV-2217 × K-260) × SPV-2217	31/78
C5	(BJV-44 × K-260) × BJV-44	26/39
C6	(SVD-803 × K-260) × SVD-803	4/28



Decision supporting tool (Flapjack) on selection of introgressed candidate breeding lines

Flapjack - 1.16.10.31

File Edit View Visualization Analysis Data Help

New Project Open Project Import Data Find Genotypes

Data Sets

Input files-Genotype-BCF1 564

Trait Data
Default View
MABC View 1
MABC Results

Chromosome: SBI_02 564 lines, 16 markers, length: 71.62

Stg3b_3 (70.1)

Line	Marker	Genotype
SPV 2217	B2 327	H
K175200	B2 328	H
K175204	B2 328	H
K175208	B2 298	H
K175206	B2 208	H
K175207	B2 208	H
K175208	B2 208	H
K175209	B2 208	H
SPV 2217	B2 327	H
K175210	B2 208	H
K175211	B2 208	H
K175212	B2 208	H
K175213	B2 208	H
K175214	B2 208	H
K175215	B2 208	H
K175216	B2 208	H
K175217	B2 208	H
K175218	B2 208	H
K175219	B2 208	H
K175220	B2 327	H
K175221	B2 208	H
K175222	B2 208	H
K175223	B2 208	H
K175224	B2 327	H
K175225	B2 327	H
K175226	B2 327	H
K175227	B2 327	H
K175228	B2 327	H
K175229	B2 327	H
K175230	B2 327	H
K175231	B2 327	H
K175232	B2 327	H
K175233	B2 327	H
K175234	B2 327	H
K175235	B2 327	H
K175236	B2 327	H
K175237	B2 327	H
K175238	B2 327	H
K175239	B2 327	H
K175240	B2 327	H
K175241	B2 327	H
K175242	B2 327	H
K175243	B2 327	H
K175244	B2 327	H
K175245	B2 327	H
K175246	B2 327	H
K175247	B2 328	H
K175248	B2 327	H

Overview

Line: SPV 2217 (1/564)
Marker: Stg3b_3 (70.1)
Genotypes: 175

Flapjack Tip:

Flapjack - 1.16.10.31

File Edit View Visualization Analysis Data Help

New Project Open Project Import Data Find Genotypes Chromosomes

Data Sets

MABC Assaid Bash Crossing (MABC)

Line	RPV (Stg_3)	RPV Total	RPV Coverage	LD (Stg_3)	Stata (Stg_3)	LD (Stg_3)	Stata (Stg_3)	DL Allele Count	Selected	Rank	Comments	Don't Sort Filter
SPV 2217	1	1	0.254	0	0	0	0	0	0	1		
K175200	0	0	0.254	50.23	2	1.60	1	4	0	2		
K175204	0.127	0.127	0.254	50.43	0	0.00	0	0	0	3		
K175208	0.127	0.127	0.254	50.43	2	1.60	1	4	0	4		
K175206	0.127	0.127	0.254	50.43	0	0.00	0	0	0	5		
K175207	0.127	0.127	0.254	50.43	2	1.60	1	4	0	6		
K175209	0.127	0.127	0.254	50.43	0	0.00	0	0	0	7		
SPV 2217	0.333	0.333	0.254	0	0	0	0	0	0	8		
K175220	0.415	0.415	0.254	50.43	0	0.00	0	0	0	9		
K175221	0.100	0.100	0.254	50.43	0	0.00	0	0	0	10		
K175222	0.402	0.402	0.254	50.43	0	0.00	0	0	0	11		
K175223	0.445	0.445	0.254	50.43	0	0.00	0	0	0	12		
K175224	0.415	0.415	0.254	50.43	0	0.00	0	0	0	13		
K175225	0.445	0.445	0.254	50.43	0	0.00	0	0	0	14		
K175226	0.415	0.415	0.254	50.43	0	0.00	0	0	0	15		
K175227	0.415	0.415	0.254	50.43	0	0.00	0	0	0	16		
K175228	0.397	0.397	0.254	50.43	0	0.00	0	0	0	17		
K175229	0.397	0.397	0.254	50.43	0	0.00	0	0	0	18		
K175230	0.396	0.396	0.254	0	0	0	0	0	0	19		
K175231	0.347	0.347	0.254	50.43	0	0.00	0	0	0	20		
K175232	0.347	0.347	0.254	50.43	0	0.00	0	0	0	21		
K175233	0.347	0.347	0.254	50.43	0	0.00	0	0	0	22		
K175234	0.347	0.347	0.254	50.43	0	0.00	0	0	0	23		
K175235	0.347	0.347	0.254	50.43	0	0.00	0	0	0	24		
K175236	0.347	0.347	0.254	50.43	0	0.00	0	0	0	25		
K175237	0.347	0.347	0.254	50.43	0	0.00	0	0	0	26		
K175238	0.347	0.347	0.254	50.43	0	0.00	0	0	0	27		
K175239	0.347	0.347	0.254	50.43	0	0.00	0	0	0	28		
K175240	0.347	0.347	0.254	50.43	0	0.00	0	0	0	29		
K175241	0.347	0.347	0.254	50.43	0	0.00	0	0	0	30		
K175242	0.347	0.347	0.254	50.43	0	0.00	0	0	0	31		
K175243	0.347	0.347	0.254	50.43	0	0.00	0	0	0	32		
K175244	0.347	0.347	0.254	50.43	0	0.00	0	0	0	33		
K175245	0.347	0.347	0.254	50.43	0	0.00	0	0	0	34		
K175246	0.347	0.347	0.254	50.43	0	0.00	0	0	0	35		
K175247	0.347	0.347	0.254	50.43	0	0.00	0	0	0	36		
K175248	0.347	0.347	0.254	50.43	0	0.00	0	0	0	37		

Auto-Results | Line count: 54, viable: 34, selected: 34

Flapjack Tip: Thanks for the evaluation of actual phenotype data with the crosses by parents (75-4)

Acknowledgement

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Dr. G Girish (Asst. Professor, Department of Genetics and Plant Breeding)

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Additional information from posters

Abstract submission id- **P144**

Poster board no- **P32**

Title- GWAS for shoot fly resistance

Authors- Satyanarayana Taddi et. al.

Abstract submission id- **P145**

Poster board no- **P31**

Title- Genetic enhancement of shoot-fly resistance and drought tolerance

Authors- Manasa KG



Thank You



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