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"Introgression of Shootfly Tolerance Traits in Sorghum (*Sorghum Bicolor (L.) Moench*) by Using Back Cross Breeding Technique"

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***Abstract* – Sorghum (Sorghum bicolor (L.) Moench) is one of the most important crops in the semiarid regions of the world. One of the important biotic constraints to sorghum production in India is the shoot fly which attacks sorghum at the seedling stage. For the present research work BC1 and BC2 population of cross IS 18551 and AKSV- 13R used where as back cross population derived from a cross between IS18551 (resistant to shoot fly) and AKSV -13R (susceptible to shoot fly). Using data of different shoot fly resistant component trait are used to introgress the shoot fly tolerance trait in Sorghum. By keeping background characters of AKSV-13R and resistant character for shoot fly from IS 18551.**

***Keywords* – Backcross, Introgression, Shootfly, Sorghum.**

I. Introduction

Sorghum is one of the most important cereal crops in the semiarid tropics (SAT) and are the fifth most important cereal crop worldwide after wheat, rice, maize and barley (Bantilan et al. 2004). Insect pests are the major biotic constraints for the production and productivity of sorghum causing economic losses over US $ 1 billion annually in the SAT. Among 100 insect pests that attack sorghum, one of the most important biotic constraints to sorghum production in India is the shoot fly (Atherigona soccata Rond.), which causes damage when sowings are delayed. The late sown crops tend to be affected by shoot fly damage as compared to the early sown crop. The infestation of shoot fly is high when sorghum sowings are staggered due to erratic rainfall distribution which is common in the SAT (Kumar et al. 2008). Many approaches have been employed to minimize the loss caused by shoot fly. These include agronomic practices, natural enemies, synthetic insecticides and host plant resistance (Kumar et al.2008). Shoot flies of the genus Antherigona are known to cause 'dead hearts' in a number of tropical grass species (Deeming 1971). They attack sorghum 5–25 days after emergence. The shoot fly larvae cut the growing tip which results in dead heart formation. Infestation causes dead hearts in seedlings as well as in tillers of old plants, resulting in considerable damage to the crop (Aruna and Padmaja 2009). However, it is not always feasible to implement all these approaches in practice. For example, early sowing is not always feasible due to short sowing window, whereas chemical control is a limiting factor for majority of farmers. The seriousness of the shoot fly problem in sorghum, combined with the high costs and toxicity hazards of using chemical control render it necessary to develop new varieties or hybrids that are resistant to this pest. Considering the economic importance of the pest, improving the genetic makeup of the plant is an important objective in the sorghum breeding programmes. Studies carried out in the past on shoot fly resistance in sorghum suggest quantitative nature of the trait (Sajjanar 2002; Folkertsma et al. 2003). In the present study, population derived from the cross of IS18551 × AKSV13R was used and phenotyping of population was done with continuous backcrossing of population.

II. Material and Methods

Plant material

A mapping population which was developed from a cross between genotypes IS18551 (shoot fly resistant) and AKSV-13R (shoot fly susceptible).The two parental genotypes are contrasting in terms of different shoot fly resistance characters. The distinguishing features of these parental genotypes are available in Satish et.al (2009). The field experiment was conducted in late kharif (rainy) season at Sorghum Research Unit, Dr Panjabrao Deshmukh Agricultural University, Akola, India, during 2011-12. The experiment was carried out. Each entry was planted in a single row and the spacing between rows was 45 cm. To attain uniform shoot fly pressure under field conditions, the fishmeal technique (Nawanze 1992) was adopted to ensure shoot fly infestation in the experimental material. Plant protection measures were avoided.

Phenotyping and data analysis

Phenotypic data on shoot fly resistance was scored for the two parental genotypes on different component traits viz., leaf glossiness, (pigmentation, oviposition (number of eggs laid on seedling at 14 and 21 days after seedling emergence (DAE), dead hearts (DH% recorded on 14th and 21st DAE), tiller dead heart and trichome density on abaxial (lower) leaf surface. Leaf glossiness was visually scored on a scale of 1–5 scores at 10 DAE (1, highly glossy (light green, shinning, narrow and erect leaves) and 5, nonglossy (dark green, dull broad and dropping leaves), pigmentation was assessed at 5 DAE (where 1, plumule or leaf sheath with dark pigment and 5, plumule or leaf sheath with green colour) following Sharma (1997). Oviposition was recorded by taking an average of the total number of eggs laid on 10 seedlings in a row. The number of eggs per seedling was calculated at 14 and 21 DAE. To record data on DH%, the total numbers of plants were initially recorded and the numbers of plants with dead hearts were subsequently recorded on 14th and 21st DAE.

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The mean values of DH% (number of dead hearts / total number of plants × 100) were recorded on 14th and 21st DAE. Trichome density was recorded at 14 DAE on the abaxial leaf surface on the central portion of the fifth leaf from the base, in three randomly selected seedlings in each row in each replication as per the procedure outlined by Sharma (1997). Briefly, the leaf segments were cleared in acetic acid: alcohol (2: 1) and transferred to 90% lactic acid in small vials. The leaf segments were then mounted on a slide in a drop of water and observed under stereomicroscope at a magnification of 40X. The number of trichomes on abaxial leaf surface was counted in three microscopic fields at random and expressed as trichome density (no./mm^2). The phenotypic correlations among different shoot fly component traits were estimated using MS Excel program (office.microsoft.com/)

III. Results

Phenotypic performance of parents

The resistant donor parent IS18551 recorded 2.37 leaf glossiness as compared to 2.32 leaf glossiness in parent KSV-13 R on 1-5 scale. Similarly differences for mean performances for pigmentation was recorded in two parents IS18551 (2.37) and AKSV-13 R (2.72).The mean percent seedling with eggs recorded after 14th and 21st days after emergence were numerically higher in AKSV-13 R (4.0% and 3.91% on 14th and 21st DAE). Similarly dead heart % at 14th and 21st DAE varied in two parents AKSV-13 R (50% and 61% on 14th and 21st DAE) and IS18551 (28% and 32% on 14th and 21st DAE). Trichome density was higher in IS18551 (64per mm^2) as compared to AKSV-13 R (22 per mm^2).

Mean phenotypic performance for shoot fly resistance component traits in the parents.

Character	AKSV– 13R (susceptible)	IS18551 (resistant)
Leaf glossiness (1-5 scale)	2.32	2.37
Pigmentation (1-5 scale)	2.72	2.37
Seeding with egg% 14,21 st DAE	4.0, 3.91	1.32, 1.86
Deadhearts % at 14, 21th	50, 61	28, 32
Trichome density(per mm^2)	22	64

Mean phenotypic performance for shoot fly resistance component traits in the BC1 of cross AKSV-13R X IS18551

Plant No.	Pigmentation (1-5 scale)	Glossiness (1-5 scale)	Trichome Density (trichome/mm^2)	Seedling with eggs		Deadheart damage		Yield per plant (gm)
				14DAE	21DAE	14DAE	21DAE	
BC_1(1)	3.18	4.45	44.11	2	2	2	3	50.43
BC_1(2)	3.33	2.62	39.33	1	0	0	0	60.34
BC_1 (3)	3.00	4.44	37.00	2	1	2	3	46.42
BC_1(4)	4.00	4.82	32.32	2	1	2	3	38.00
BC_1(5)	2.42	3.00	31.55	3	1	4	2	34.67
BC_1(6)	3.00	2.23	42.73	1	1	1	2	57.30
BC_1(7)	4.00	2.52	44.64	1	2	1	2	51.40
BC_1(8)	4.56	2.38	44.52	1	2	2	1	50.00
BC_1(9)	3.33	1.23	52.33	0	0	0	1	60.00
BC_1(10)	3.86	2.22	52.00	0	1	1	0	63.00
BC_1(11)	3.12	4.63	41.73	2	1	2	2	45.43
BC_1(12)	3.56	3.12	46.86	1	1	1	1	49.54
BC_1(13)	3.65	3.00	41.75	1	2	1	2	48.87
BC_1(14)	3.12	1.28	44.06	0	1	1	0	54.76
BC_1(15)	3.25	1.21	53.28	1	0	0	0	58.66
BC_1(16)	2.67	1.43	40.25	0	1	1	0	65.21

*BC_1 - Back cross 1, ( ) – plant row no.

Mean phenotypic performances for shoot fly resistance component traits in the BC_2 of cross AKSV-13R X IS18551

	Pigmentation	Glossiness	Trichome Density	Seedling with eggs		Deadheart damage		Yield per plant (gm)
	(1-5 scale)	(1-5 scale)	(trichome/mm2)	14DAE	21 DAE	14DAE	21DAE	
BC2P1	2.75	3.75	52.33	2	2	2	1	33.50
BC2P 2	1.57	2.25	46.13	1	2	1	1	65.14
BC2P 3	3.20	3.55	52.29	2	1	2	1	40.40
BC2P 4	3.00	2.75	47.60	1	1	1	1	50.63
BC2P 5	3.40	3.25	46.47	0	0	3	0	41.00
BC2P 6	2.67	2.15	52.26	1	1	1	1	66.67
BC2P 7	3.29	3.86	54.60	2	2	2	4	34.00
BC2P 8	3.20	3.66	47.33	2	1	1	2	35.00
BC2P 9	1.00	2.00	43.22	1	2	2	3	53.00
BC2P10	2.00	1.76	52.59	1	1	1	1	76.67

BC2P11	3.40	2.10	52.29	1	2	1	4	57.60
BC2P12	3.50	3.12	52.30	2	3	2	4	46.60
BC2P13	3.33	2.10	58.06	2	2	2	3	53.50
BC2P14	2.67	4.33	50.78	1	1	2	4	31.67
BC2P15	2.00	2.00	44.78	1	1	2	3	31.33
BC2P15	2.00	2.00	44.78	1	1	2	3	31.33
BC2P16	3.50	2.00	53.00	2	3	2	2	50.00
BC2P17	3.40	2.80	44.27	2	1	2	3	40.20
BC2P18	3.57	4.10	44.73	2	2	4	3	35.00
BC2P19	2.33	1.12	45.52	1	1	2	1	70.00
BC2P20	4.00	1.56	41.11	2	1	2	2	60.00
BC2P21	3.60	4.10	45.73	1	3	1	4	32.40
BC2P22	5.00	2.15	43.11	2	3	2	3	50.00
BC2P23	3.80	2.00	45.40	1	2	2	2	57.40
BC2P24	1.33	4.13	40.33	1	3	2	5	32.00
BC2P25	3.00	1.10	44.11	1	2	1	2	68.50
BC2P26	3.17	4.17	50.04	1	2	3	3	39.33
BC2P27	3.38	1.88	45.33	1	1	2	1	58.00
BC2P28	3.18	4.55	43.55	1	2	2	4	34.36
BC2P29	3.33	2.13	41.09	1	1	2	1	52.00
BC2P30	3.00	2.00	42.73	1	1	1	2	57.30
BC2P31	2.60	2.20	44.64	1	2	1	2	51.40
BC2P32	2.67	2.00	44.52	2	1	2	3	50.00
BC2P33	4.00	2.00	52.33	2	1	2	2	60.00
BC2P34	5.00	2.00	52.00	1	1	1	0	50.00
BC2P35	3.29	3.71	41.73	1	2	2	3	37.14
BC2P36	3.33	3.12	46.86	1	4	1	2	44.22
BC2P37	3.86	3.71	41.75	2	1	2	3	33.57
BC2P38	5.00	3.25	44.06	1	2	4	1	40.00
BC2P39	1.50	4.15	53.28	2	1	2	3	35.50
BC2P40	2.75	4.00	40.25	4	1	3	2	39.25
BC2P41	4.40	2.80	42.49	1	0	1	4	58.40
BC2P42	4.25	3.50	43.61	1	4	1	3	39.50
BC2P43	2.67	1.33	45.67	2	2	2	1	55.00
BC2P44	4.11	1.67	42.07	2	1	2	2	58.56
BC2P45	3.40	2.20	45.16	3	1	3	2	52.00
BC2P46	1.33	5.00	31.26	1	2	3	2	30.00
BC2P47	4.25	4.75	38.31	1	2	1	2	42.50
BC2P48	2.50	1.00	40.06	0	0	0	0	80.00
BC2P49	2.82	3.15	40.66	1	1	1	2	43.29
BC2P50	4.00	1.33	45.56	1	1	2	3	57.00
BC2P51	2.00	1.65	41.06	1	1	2	3	58.50
BC2P52	2.00	1.66	41.94	1	1	2	3	57.86
BC2P53	2.00	4.50	48.67	1	1	2	1	31.00
BC2P54	2.40	1.70	45.28	3	1	3	2	54.60
BC2P55	3.00	2.32	45.80	1	2	1	3	50.63
BC2P56	3.75	4.50	51.58	1	1	2	3	22.00
BC2P57	4.00	3.16	38.22	1	0	2	1	43.00
BC2P58	1.75	1.56	44.87	2	1	1	2	59.00
BC2P59	2.80	4.00	52.38	0	0	0	0	25.60
BC2P60	5.00	2.13	37.44	1	0	4	1	50.00
BC2P61	4.00	2.18	41.28	1	1	2	2	50.00
BC2P62	4.71	4.18	54.16	3	1	3	2	35.00
BC2P63	3.20	4.53	51.44	1	1	1	4	32.20
BC2P64	2.67	2.00	57.52	1	4	1	3	54.00
BC2P65	2.80	3.00	54.40	1	2	4	1	49.40
BC2P66	3.00	1.50	50.26	2	1	1	1	59.13
BC2P67	4.00	4.50	44.25	4	1	1	3	39.25
BC2P68	5.00	2.50	57.50	0	0	3	2	55.00
BC2P69	3.00	1.75	56.11	2	1	2	3	60.00
BC2P70	3.00	2.00	48.44	1	2	1	3	60.00
BC2P71	4.67	4.52	48.52	0	0	0	0	35.00
BC2P72	4.00	4.36	39.33	1	0	0	0	35.00

Phenotypic correlation coefficient among the six morphological traits in BC_1 derived from cross AKSV-13R X IS18551

	Pigment mean	Leaf glossiness	Trichome Density	Seedling with Egg 14DAE	Seedling with Egg 21DAE	Dead heart 14DAE	Dead heart 21DAE	Yield/ Plant
Pigmentation	1	0.53*	-0.44	0.50*	0.21	0.62**	0.27	-0.68**
Leaf glossiness		1	-0.72**	0.92**	0.28	0.83*	0.74*	-0.86**
Trichome Density			1	-0.67**	-0.20	-0.68**	-0.53*	0.68**
Seedling with egg 14 DAE				1	0.20	0.77**	0.73**	-0.85**
Seedling with egg 21 DAE					1	0.45*	0.48*	-0.34
Dead heart 14 DAE						1	0.57*	-0.80**
Dead heart 21 DAE							1	-0.72**
Yield/plant								1

** Significant at P= 0.01= highly significant,
* Significant at P= 0.05 = significant,
N.S = Non significant.

Pigmentation

Correlation of pigmentation was studied with different parameters such as leaf glossines, trichome density, seedling with egg, dead heart and yield per plant revealed that pigmentation was positively correlated with leaf glossiness, seedling with egg and dead heart at 14th and 21st DAE and negatively correlated with trichome density, yield/plant. Whereas pigmentation was significantly correlated for leaf glossiness (0.53*) seedling with egg at 14th DAE (0.50*), highly significantly correlated for dead heart at 14th DAE (0.62**)

Glossiness

Correlation of glossiness with different parameters such as pigmentation, trichome density, seedling with egg, dead heart and yield per plant revealed that glossiness was positively correlated with seedling with egg at 14th (0.92**) and 21st (0.28**)DAE, dead heart at 14th (0.83*) and and 21st (0.74*)DAE negatively correlated with trichome density (-0.72**), yield/plant (-0.86**). Whereas glossiness was significantly correlated for dead heart on 14th (0.83*) and 21st (0.74*) DAE, highly significantly correlated for seedling with egg at 14th DAE (0.92**)

Trichome Density

Correlation of trichome density was studied with different parameters such as seedling with egg, dead heart and yield per plant reveled that trichome density was positively correlated with yield (0.68**) negatively correlated with seedling with egg at 14th (-0.67**) and 21st (-0.20) DAE, dead heart at 14th (-0.68**) and 21st (-0.53*)DAE. Whereas highly significantly correlated for yield (0.68**)

Seedling with Egg

Correlation of Seedling with Egg of was studied with different parameters such as dead heart and yield per plant reveled that seedling with egg was positively correlated with dead heart at 14th (0.77**)and and 21st (0.73**)DAE negatively correlated with trichome density (-0.72**), yield/plant(-0.86**).Where as highly significant for dead heart at 14th and 21st DAE ,seedling with egg was positively correlated with Dead heart at 14th (0.45*) and 21st (0.48*)DAE

Dead Heart

Correlation of Dead heart with yield reveled that yield was negatively correlated with dead heart for both 14th (-0.80**) and 21st DAE (-0.72**)

Yield

Correlation with yield was studied with different parameters such as leaf glossiness, pigmentation, trichome density, seedling with egg, dead heart revealed that yield was highly positively significantly correlated with trichome density (0.68**) and negatively correlated for pigmentation (-0.68**), glossiness (-0.86**), seedling with egg 14th (-0.85**) and 21st (-0.34) DAE and Dead heart 14th (-0.80**) and 21st (-0.72**)

Phenotypic correlation coefficient among the six morphological traits in BC_2 derived from cross AKSV-13R X IS18551

	Pigment mean	Leaf glossiness	Trichome Density	Seedling with Egg 14DAE	Seedling with Egg 21DAE	Dead heart 14DAE	Dead heart 21DAE	Yield/ plant
Pigmentation	1	0.06	0.28*	0.03	-0.14	0.09	-0.15	-0.07
Leaf glossiness		1	-0.09	0.01	0.03	0.03	0.15	-0.87**
Trichome Density			1	0.07	-0.03	-0.04	-0.14	0.10
Seedling with egg 14 DAE				1	0.08	0.28*	0.21	-0.07
Seedling with egg 21 DAE					1	0.02	0.43**	-0.08
Dead heart 14 DAE						1	0.09	-0.16
Dead heart 21 DAE							1	-0.22
Yield/plant								1

** Significant at P= 0.01= highly significant,
* Significant at P= 0.05 = significant,
N.S = Non significant

Pigmentation

Correlation of pigmentation was studied with different parameters such as leaf glossines, trichome density, seedling with egg, Dead heart and yield per plant revealed that pigmentation was positively correlated with leaf glossiness(0.06),trichome density (0.28*) seedling with egg at 14th (0.03)DAE dead heart 14th (0.09) and negatively correlated with seedling with egg at 21st (-0.14), Dead heart 21st (-0.15) , yield/plant (-0.07).Where as pigmentation was significantly correlated for trichome density(0.28*)

Glossiness

Correlation of glossiness was studied with different parameters such as trichome density, seedling with egg, Dead heart and yield per plant revealed that glossiness was positively correlated with seedling with egg at 14th (0.01) and 21st (0.03)DAE Dead heart 14th (0.03) and 21st (0.15) negatively correlated with trichome density (-0.09), yield/plant (-0.87**)

Trichome Density

When correlation of trichome density was studied with different parameters such as seedling with egg14th (0.07) and yield per plant (0.10). It was observed that trichome density was positively correlated with seedling with egg14th (0.07), yield (0.10) and negatively correlated with seedling with egg at 21st (-0.03) DAE, dead heart at 14th (-0.04) and and 21st (-0.14) DAE

Seedling with Egg

Correlation Seedling with Egg of was studied with different parameters such as Dead heart and yield per plant revealed that seedling with egg was positively correlated with dead heart at 14th (0.28)and and 21st (0.21)DAE negatively correlated with yield/plant(-0.07). Whereas highly significantly correlated for dead heart at 21st (0.43**) DAE seedling with egg was positively correlated with Dead heart at 14th (0.02)

Dead Heart

Correlation of dead heart with yield It was observed that (-0.16) and 21st DAE (-0.22)

Yield

Significantly positive correlation was reported for trichome density (0.10) and negatively correlated with pigmentation (-0.07) and highly negative correlated with leaf glossiness (-0.87**) and seedling with egg and 14th (-0.07), 21st (-0.08), dead heart at 14th day (-0.16) and 21st (-0.22)

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