

NEWLY DEVELOPED CONVENTIONAL SOYBEAN JTN-5110 HAS RESISTANCE TO MULTIPLE PATHOGENS



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INTRODUCTION

Soybean [*Glycine max* (L.) Merr], grown for its edible protein and oil, is a very important agronomic crop worldwide. The soybean cyst nematode (SCN, *Heterodera glycines* Ichinohe) annually is the single most damaging root parasite of soybean in the USA. Initially discovered in the 1950s in North Carolina, it is currently found in all soybean growing states (Koenning and Wrather, 2010). The annual combined yield losses due to nematodes and fungal pathogens are estimated to be over \$1 billion. Predominant fungal diseases include stem canker (*Diaporthe phaseolorum* var. *meridionalis*), sudden death syndrome (SDS, caused by *Fusarium solani* f. sp. *glycines*), and Frogeye leaf spot (FLS, *Cercospora sojina*). Primarily, resistant cultivars have been an effective means of controlling parasites and foliar pathogens in soybean, but also caused major shifts especially in nematode populations. Over time, these genetically variable nematode populations have adapted to resistant cultivars. The disease pressure placed on cultivars by these pathogens require broader resistance for more durable resistance in current cultivars. Newly developed conventional soybean JTN-5110 meets the new challenges with its broad resistance to nematode populations and fungal pathogens with high yield potential in the Mid-South.

MATERIALS AND METHODS

Soybean JTN-5110 is an F₂-derived line from the cross J98-32 x Anand. The cross was made in 1999 at USDA-ARS, Jackson, TN. The pedigree for J98-32 includes Manokin x Fowler. Manokin was derived from cross L70L-3048 x D74-7824, and is resistant to SCN races 1 and 3 (Kenworthy et al. 1996); Fowler was derived from cross Holladay x Hartwig, and is resistant to SCN races 2, 3, 5, and 14 (Young, 2001). Anand also shares the pedigree Holladay x Hartwig, and derives its SCN resistance from Peking and PI 437654 via Hartwig (Anand, 1992). Progenies of the cross J98-32 x Anand were advanced using bulk-row method. Based on the agronomic appearance, several individual F₂ plants were harvested and planted out to rows for progeny testing.

Cyst Nematode Bioassay: Selected F_{2:5} progenies were screened in the greenhouse for two nematode HG Types (Niblack et al., 2002). One seed of each progeny was planted in sterile soil mix with three replications per each HG Type. At the time of planting, 2,000 eggs of the population of SCN were added to each pot. Approximately 30 days after planting, plants were rated based on the number of cysts on the roots. The ratings were as follows: 1 = 0-5 cysts, 2 = 6-10 cysts, 3 = 11-20 cysts, 4 = 21-40 cysts, and 5 = >40 cysts. The HG Type was confirmed using established differential lines (Golden et al., 1970; Schmitt and Shannon, 1992).

Marker Assisted Selection: Nematode resistance was confirmed over multiple years using DNA markers. Simple sequence repeat markers (SSR) associated with nematode resistance were used in a PCR using the methods already described (Arelli et al., 2006, 2007; Carter et al., 2011; Arelli et al., 2014). JTN-5110 demonstrated the same reaction as cv. Hartwig with Satt309 and Sat_168, associated with *rhg1*, and Satt574, associated with a quantitative trait locus (QTL) cqSCN-005 (Kazi et al., 2010). Reactions were scored and recorded manually.

Evaluations for Fungal Pathogens: Screening for stem canker and SDS was conducted as part of the USDA Uniform Soybean Tests – Southern States following established methods (Gillen and Shelton, 2013). JTN-5110 was evaluated for FLS resistance in Milan, TN from 2010 to 2012 using an established method (Mengistu et al., 2011).

Botanical Description and Seed Traits: JTN-5110 is a group V soybean, determinate with purple flowers and tawny pubescence. Seeds are yellow with black hila. From 2010-2013 in the USDA Uniform Soybean Tests – Southern States, JTN-5110 matured 3 days later than check variety 5002T (Pantalone et al., 2004). JTN-5110 is taller than 5002T, at 74 cm and 64 cm, respectively. Both lines have an average lodging score of 1.6. JTN-5110 has a slightly smaller seed size at 14.9 g per 100 seed compared to 5002T's 15.2 g. JTN-5110 and 5002T have similar protein content, testing at 402 and 405 g kg⁻¹, respectively. Oil content for JTN-5110 is 214 g kg⁻¹ compared to 219 g kg⁻¹ for 5002T.

RESULTS

Table 1. Nematode and disease reactions of JTN-5110 from the USDA Uniform Soybean Tests – Southern States (Gillen and Shelton, 2010, 2011, 2012, 2013).

Year	Test Name	SCN			Stem Canker	SDS DX
		HG Type 1.2.5.7 (Race 2)	HG Type 0 (Race 3)	HG Type 2.5.7 (Race 5)		
		1-5 [†]			score [‡]	index [§]
2010	Preliminary V	1	1	.	R	.
2011	Uniform V	1	1	1	R	.
2012	Uniform V	1	1	1	.	1
2013	Uniform V	1	1	1	R	28

[†]1 = 0-5 cysts; 2 = 6-10 cysts; 3 = 11-20 cysts; 4 = 21-40 cysts; 5 = >40 cysts on the root.

[‡]R = resistant, S = susceptible, SS = segregating for susceptible and resistance plants, MS = moderately susceptible, MR = moderately resistant.

[§]DX = disease index = (DI × DS / 9) where disease incidence (DI) is the % of plant exhibiting symptoms and disease severity (DS) is a score on a 1-9 scale where 1 = mild chlorosis, 5 = severe leaf scorch, and 9 = premature death of plant.

Table 2. Frogeye leaf spot foliar disease rating of JTN-5110, conducted in Milan, TN from 2010 to 2012.

Year	No. of Reps	Average Score [†]
2010	3	1.3
2011	3	0.7
2012	3	2.0
Average	-	1.3

[†]0-9 scale in which 0 = no disease and 9 = 90% of leaf area diseased.

Table 3. One year and three year average yield of JTN-5110 compared to a check variety in the USDA Uniform Soybean Tests – Southern States (Gillen and Shelton, 2013).

Strain/Variety	Yield	
	2013	2011-2013
	kg ha ⁻¹	
JTN-5110	3900	3679
5002T	3813	3605
LSD (0.05)	262	.
CV (%)	12.4	.

Table 4. One year and three year average yield of JTN-5110 compared to check varieties in the Soybean Variety Performance Tests in Tennessee (Allen et al., 2013).

Strain/Variety	Yield	
	2013	2011-2013
	kg ha ⁻¹	
JTN-5110	4304 ± 135	3699 ± 67
AG5233	4170 ± 135	.
Osage	3497 ± 135	3699 ± 67
LSD (0.05)	336	269
CV (%)	11.0	10.2



Figure 1. JTN-5110 ready for harvest in Milan, TN on October 24, 2011.

SUMMARY

We have developed a soybean line, JTN-5110, with resistance to multiple pathogens with excellent yield potential. Progenies of the cross (J98-32 X Anand) were advanced using bulk row method. JTN-5110 was first submitted for testing in the USDA Uniform Soybean Tests – Southern Region in 2010 and has shown consistent resistant reactions to SCN races 2, 3, and 5, as well as stem canker. Screening conducted in Milan, TN from 2010-2012 also shows resistance to FLS. In the 2013 Soybean Performance Tests in Tennessee, JTN-5110 was the highest yielding (4304 +/- 135 kg ha⁻¹) soybean in the group V conventional test. Over three years (2011-2013), it averaged 3699 kg ha⁻¹. Ratings taken in 2013 also indicate resistance to SDS. In the USDA Uniform Soybean Tests – Southern Region, the yield was 3900 kg ha⁻¹ for 2013, with a three year (2011-2013) average of 3679 kg ha⁻¹. With renewed interest in high yielding conventional soybeans having resistance to multiple pathogens, growers can be highly benefitted by its adoption. JTN-5110 is also an excellent parent material in crosses to develop more desirable cultivars.

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