New Soybean Accessions Evaluated for Reaction to *Heterodera glycines* populations

Prakash R. Arelli[1], Alemu Mengistu[1], Randall L. Nelson[2] and Silvia R. Cianzio[3].
[1]USDA-ARS-MSA, Jackson, TN; [2]USDA-ARS-MWA, Urbana, IL; [3]Iowa State University, Ames, IA

UID: 78636

INTRODUCTION

Soybean cyst nematode (SCN, *Heterodera glycines* Ichinohe) is the most pervasive pest of Soybean [*Glycine max* (L.) Merr.], in the USA and worldwide. First reported in North Carolina (Winstead et al., 1955), SCN has since spread throughout most of the soybean production states. In 2012, SCN reduced soybean yields in the USA by an estimated 10.34 millions of bushels (Koenning, 2013). These losses have remained stable with the use of resistant cultivars but over time nematodes will adapt to deployed resistance alleles.

Soybean resistance to SCN was initially identified by Ross and Brim (1957) and included Peking, PI90763, PI209332 and PI84751. Soybean germplasm continued to be introduced mainly from China, and today 118 resistant sources are identified in the USA (Arelli et al., 2000). Currently used resistant cultivars primarily utilized three or four sources of resistance and include Peking, PI88788, PI209332 and PI437654. Several resistance genes are common among them (Arelli and Anand, 1988). It is important to identify new accessions with resistance to SCN as the first step to finding new alleles to provide more durable resistance. We have evaluated in the greenhouse newly available accessions from the USDA Soybean Germplasm Collection for reaction to nematode populations or HG Types (Niblack et al., 2000).

MATERIALS AND METHODS

We have previously reported methods for nematode collection and culture in the greenhouse for developing near homogeneous populations for stable reactions (Arelli et. al., 2000). One hundred accessions from USDA soybean germplasm collection (Courtesy of Randall Nelson, curator) were bioassayed in this research. Bioassays were performed in the greenhouse for SCN population race 3 (HG Type 0) during 2009-2012. The methods used were described in Arelli et al., (2000) with modifications (Arelli et al., 2009). Seven seedlings were included for each of the 100 accessions, susceptible controls, and indicator lines. Each seedling within a genotype represented a single replication, the test was completely randomized and repeated twice. Approximately 30d after inoculation, plant roots were individually washed with a strong jet of water to dislodge white females and cysts. These were counted under a stereomicroscope, and a female index (FI%) was calculated for the number of females developed on each line in each replication (Golden et al., 1970). Data for two tests were combined for ANOVA of female indices by the Statistical Analysis System Software (SAS, 1991) and means were separated with Fisher's LSD based on a significant F test (Table 1). Ratings of resistant (FI=0-9%), moderately resistant (FI 10-30%), moderately susceptible (FI=31-60%), and susceptible (FI = >60%) used to classify the reaction of accessions were based on Schmitt and Shannon (1992).

Table 1: Reaction of soybean accessions for SCN Race 3 population.

ID accession	Cultivar	Maturity group	Descriptor	FI†%	Reaction rating
FC033243-1	(Anderson)	IV	N WGENBr SYY	54	MS
FC033243-2	(Anderson)	IV	N WGENBr SYY	63	S
PI070457		II	D WGENBr SYBf	65	S
PI081761	Aojiro	III	N WGENBl SYY	62	S
PI087606	Oiarukon	IV	N PGENBr IYBf	76	S
PI103419B		IV	N PGESdnBr IYY	67	S
PI123577B		IV	N WGENBr DYBf	50	MS
PI157487B	(Well-man)	IV	N WGENBr DGnBf	43	MS
PI159923B	(Casa Grande)	IV	D DpGESspBr DYY	65	S
PI261466	Higodaizu	III	D WTANTn DGnBr	86	S
PI261467	Saikai No. 3	III	D PGENTn SYBf	75	S
PI339865A	Baemking	IV	D PTESspBr DBlBl	46	MS
PI407386D		I	N PGENTn IYY	49	MS
PI407946-2		IV	D PGESspBr SYY	40	MS
PI417150	Mikawashima	0	D WGANBr IYBf	59	MS
PI423952	Saikai 27	II	N PGENBr SYY	54	MS
PI438205		I	N PGENBr IYIb	65	S
PI438437		II	N WTESspBr IBrBr	51	MS
PI464917	Ji Ti 3	II	N WGESspBr SYY Na	48	MS
PI468904		0	N PTVaSspBr IBlBl Na Sw,4sd	50	MS
PI468905		0	N PTANBr SBlBl Na Sw,4sd	70	S
PI468906		0	N PTVaSspBr IBlBl Na Sw	67	S
PI468907		I	N WTSaNBr BBlBl Flk Sw,4sd	61	S
PI468908		000	N WTENBr BBlBl Na Sw	56	MS
PI468909		0	N PTASspBr IBlBl Na Sw	113	S
PI468910		0	N PLtENBr BBlBl Na Sw	84	S
PI468911		00	N PTANBr IBlBl Na Sw	81	S
PI468912		00	N PTVaSspBr BBlBl Na Sw,4sd	80	S
PI468913		000	N PNgANBr IBrBr Sw	80	S
PI468919		III	N PTSaNBl SBlBl Flk Sw	16	MR
PI483459		I	N PTASpBr IBlBl Flk Sw	106	S
PI506590E	(Bansei ao daizu)	IV	D PTENBr IGnBl Gnc	108	S
PI506838A	Kantou 7	III	D WTASspTn DYBr	73	S
PI506838B	(Kantou 7)	III	D WTASspTn IYTn	37	MS
PI507268	Shiro higo	IV	D WGANTn DYBf	35	MS
PI507686B	(Kisinjevskaja 19)	0	D WTENBr DYBr	55	MS
PI507686C	(Kisinjevskaja 19)	I	N PTENBr DYBrbl	m	m
PI507704A	Tercinskaja 24	00	N PTENBr SYBr	46	MS
PI507704B	(Tercinskaja 24)	000	N PTENBr SYBr	61	S
PI512322A	Imeretinskaja	I	N PTENBr IYBrbl	43	MS
PI512322D	(Imeretinskaja)	II	N WTENBr IYBr Sph Lft5	8	R
PI522186	Arkadia Odessaja	0	D PTENBr SYBr Abh	4	R
PI522187	Krasnogradskaja 1	000	N PGENTn DYY	61	S
PI522188A	VNIIMK 3985	I	D PTENBr SYBrbl Abh	46	MS
PI522188B	(VNIIMK 3985)	0	D WTENBr SYBrbl Abh	37	MS
PI522189		I	S PGENBr SYIb	40	MS
PI522190		I	N PTENBr IYBl	11	MR
PI522191		II	N WTESspBr IBrBr	15	MR
PI522192A		0	N WTESspBr SBlBl	13	MR
PI522192B		0	N WTESspBr SBlBl	30	MR
PI525492		II	D WTESspBr SBlBl	m	m
PI532472	Soya	II	D WGESspBr IGnLbf Vhil	m	m
PI538401A	AV 62	III	N PTENBr IYBl Na	50	MS
PI538401B	(AV 62)	IV	N PTENBr IYBl Na,Lft4,5	31	MS
PI538406	Sapporo Midori	00	D WGESspBr DGnLbf	19	MR
PI538408	Shirofusa	00	D WGSaSspBr DGnLbf	12	MR
PI567165	He long zao shou dou	0	N WGENBr IYY Na	63	S
PI567488A	Di liu huang dou 2	IV	N WGENBr IYRbf	18	MR
PI567488B	(Di liu huang dou 2)	IV	N WGENBr IYDbf	6	R
PI567488C	(Di liu huang dou 2)	IV	N WGENBr IYDbf	10	MR
PI567650C	(Ru nan huang mao dou)	IV	D WTANBr IYBr	16	MR
PI567675	Yu cheng xiao tie jiao huang	IV	N WGSaNBr IYBf	45	MS
PI567676A	Yu xian da zi huang	IV	N WGSaNBr IYBf	15	MR
PI567676B	(Yu xian da zi huang)	IV	N WGENBr IYBf	18	MR
PI567677	Yu xian huang dou	IV	D WTANBr IGBl	38	MS
PI567678	Zhe cheng huang yuan dou	IV	N PGENTn IYBf	26	MR
PI567679A	Zhe cheng tie jiao huang	III	N PGASspBr IYBf	27	MR
PI567679B	(Zhe cheng tie jiao huang)	IV	N PLtENBr IYBr	19	MR
PI567679C	(Zhe cheng tie jiao huang)	IV	N WGENBr IYBf	41	MS
PI567681	Zhen ping ben huang dou	IV	N WGSaNBr IYBf	55	MS
PI567683A	Zheng zhou niu yao qi	IV	S WGANBr IYBf	66	S
PI567684A	Zheng zhou zao shu xiao zi huang	IV	S WGANBr IYBf	43	MS
PI567684B	(Zheng zhou zao shu xiao zi huang)	IV	S WGSaNBr IYBf	38	MS
PI567685	Zhong mou tie jiao er cao	IV	N WLtENBr IYBr Sph Dab	31	MS
PI567686	Fu yang (3)	III	S PGANBr IYBf	49	MS
PI567687	Fu yang (4)	IV	N WGENTn IYBf	37	MS
PI567688A	Fu yang (5)	III	S PGANBr IYBf	m	m
PI567688B	(Fu yang (5))	IV	N PGANTn IYBf	54	MS
PI567689	Fu yang (6)	IV	D WGENBr IYBf	33	MS
PI567690	Fu yang (7)	III	S PGANBr IYBf	28	MR
PI567691	Fu yang (8)	IV	S PGANBr IYBf	55	MS
PI567692	Fu yang (10)	IV	S WGSaNBr IYBf	34	MS
PI567693	Fu yang (11)	IV	N PGENBr IYBf	29	MR
PI567694	Fu yang (12)	IV	N WGENBr IYBf	35	MS
PI567695	Fu yang (14)	III	S PGANBr IYBf	33	MS
PI567696A	Fu yang (15)	III	S WGENBr IYBf	46	MS
PI567696B	(Fu yang (15))	IV	N PGANBr IYBf Lft5	40	MS
PI567696C	(Fu yang (15))	IV	S WGANTn IYBf	41	MS
PI567697	Fu yang (16)	III	S PGANBr IYBf	m	m
PI567698A	Fu yang (17)	IV	S WGENBr IYBf	36	MS
PI567698B	(Fu yang (17))	IV	S WGANBr IYBf	67	S
PI567699	Fu yang (18)	III	S PGANBr IYBf	63	S
PI567700	Fu yang (19)	III	S PGANBr IYBf	18	MR
PI567701	Fu yang (20)	IV	S PGANBr IYDbf	54	MS
PI567702A	Fu yang (21)	IV	S WGANBr IYDbf	48	MS
PI567702B	(Fu yang (21))	IV	S WGENBr IYDbf	43	MS
PI567703	Fu yang (22)	IV	S WGENBr IYRbf Vhil	67	S
PI567704	Fu yang (23)	IV	S PGANBr IYDbf	77	S
PI567705	Fu yang (24)	III	S PGANBr IYBf	37	MS
PI567706A	Fu yang (25)	III	S PGENBr IYIb	38	MS
Standard host differentilas					
PI548402 (Peking)		IV		2	R
PI548316 (Cloud)		III		18	MR
PI88788		III		4	R
PI89772		IV		1	R
PI90763		IV		1	R
PI209332		IV		6	R
PI437654		III		1	R
Essex		V		58	MS
Susceptible Control					
5601T				100	S
LSD (P = 0.05)				11.36	
CV(%)				24.3	

†Female index is the number of white, yellow and brownish colored SCN females occurring on a soybean plant 30± 1 d after inoculation, expressed as the percentage of mean number of females on 5601T. Reaction ratings indicated by FI values include: resistant (R) = 0 to 9, moderately resistant (MR) = 10 to 30, moderately susceptible (MS) = 31 to 60, and susceptible =>60.

RESULTS AND DISCUSSION

We identified several accessions with various levels of resistance to SCN population Race 3 (HG Type 0) and these are included in Table 1. These included three resistant, 19 moderately resistant and 45 moderately susceptible. We will continue to evaluate these and other accessions for reaction to other nematode populations. Further, the resistant lines identified in this research will be evaluated for their genetic relationship to commonly used sources of resistance in cultivar breeding.

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