RECURRENT SELECTION PERFORMANCE FOR FOV RACE 4 RESISTANCE IN SELECTED GERMPLASM AND PROGENY

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Abstract

Recurrent selection is being used to improve *Fusarium oxysporum* f. sp. *vasinfectum* race 4 (FOV4) resistance in Upland (*Gossypium hirsutum* L.) and Pima (*G. barbadense* L.) cotton using naturally infested fields and artificially inoculum-greenhouse sites. Our primary objective is to introduce a known FOV4 dominant gene that has shown resistance in Pima into the Upland species. In 2013, 2014 and 2015, we evaluated 1155 entries for resistance. These entries were exposed to FOV4 pressure in naturally infested fields and rated. Selected entries were then self- and cross pollinated. Parental lines and F_1 populations were then inoculated with FOV4 and grown under greenhouse conditions for rating and reselection. This research will provide additional germplasm to broaden the genetic base for FOV4 resistant cotton.

Introduction

In California, Fusarium wilt of cotton is a serious fungal disease that is caused by *Fusarium oxysporum* f. sp. *vasinfectum* (FOV). Practices that have reduced the effects include not planting in sandy or sandy-loam textured soils that have a high infestation of root knot nematode and use crop rotation to help manage soil inoculum levels. This has been useful with FOV races 1 and 3, but *Fusarium oxysporum* f. sp. *vasinfectum* (FOV4) has been found to cause substantial damage in the absence of root knot nematode (*Meloidogyne incognita*) and persists even when crop rotation is practiced. Thus, the only long-term management of FOV4 is developing resistant cultivars. One objective of this study is to evaluate a known resistant FOV4 dominant gene from Pima (PS6) for potential introgression into Upland germplasm. The second objective is to identify and develop Upland germplasm with improved tolerance or resistance to FOV4.

Materials and Methods

Field Evaluations

Entries were planted in a field naturally-infested with FOV4. Approximately 60 seeds per entry were seeded in 5 x 1 meter plots and replicated three times in a complete randomized block design in sandy-loam soil. During the growing season, plant responses to inoculum pressure were assessed through evaluations of root and stem vascular staining levels, plant mortality, foliar wilt symptoms and measures of relative plant vigor. For both the foliar and root vascular assessments, a numerical rating scale of 0 to 5 was used in evaluating the severity of apparent disease symptoms (Table 1). Five plants were randomly chosen per plot for vascular root staining (VRS) and foliar ratings (FS). To observe vascular staining plants were cut from the cotyledon node to the distal root.

Greenhouse Evaluations

For greenhouse evaluations, cotton seedlings at the two to three leaf stage were root dip inoculated in a conidial suspension of FOV4 1x106 spores/ml for two minutes and transplanted into 4" pots. Entries were evaluated for VRS and FS at three to four weeks, allowing time for disease development. Five plants were randomly chosen per entry and evaluated for VRS and FS using a 0 to 5 scale (Table 1). For VRS plant stems were cut from the soil line toward the root and examined for vascular staining.

Table 1. Disease severity rating scale

Score	Foliar symptom	Vascular symptom
0	No symptom	No symptom
1	Chlorosis, wilting	Light, discontinuous streaks
2	Necrotic lesion on 1 leaf	Continuous, light to dark streaks
3	Necrotic lesions on 2+ leaves	Vascular streaking + cortical stain
4	Dieback, defoliation	Root blackening and water soaking
5	Whole aerial death	Root death

Summary

In 2013, we evaluated 511 entries in the field. In the "PS6 X TM1" and "TM1 X PS6" variety there were 175 entries, of which 14 (8%) were selected. Ten (7%) of the 138 "Shorty X PS6" and "PS6 X Shorty" entries were selected. 19 (15%) of the 129 "FBCX-2 X Shorty" and "Shorty X FBCX-2" entries were selected. In the "SJ10" variety, 5 (50%) of 10 entries were selected. The 48 selections were then increased for further FOV4 greenhouse evaluations and reselections. Eight entries (1.5% of the 2013 entries) were reselected and subjected to FOV4 field pressure in 2015 for further evaluation.

Table 2. 2013 Field selections of FOV4 resistant lines and subsequent pollination events

Parent line	Pollination	Pedigree frequency	Objective
TM1 x PS6	Self	14	FOV4 resistance selection
Shorty x PS6	Self	10	FOV4 resistance selection
Shorty x FBCX-2	Self	19	FOV4 resistance selection
SJ10	Self	5	FOV4 resistance selection
Total selections		*48*	

In 2014 we evaluated 316 new accessions and selected 39 (12%) entries for increase and introgression of Pima resistant and Upland varieties under FOV4 field and greenhouse evaluations (Table 3). Ten (3% of the 2014 new accessions) entries were selected based on greenhouse assays and returned to the field in 2015. In addition, 37 new crosses (F_1's) were created and planted under FOV4 pressure in the field and greenhouse in 2015 for selection and increase.

Table 3. 2014 Field selections of Fov4 resistant lines and subsequent pollination events

Parent line group	Pollination	Pedigree frequency	Objective
SA	Self	23	Fov4 resistance selection
PS	Self	10	Fov4 resistance selection
GH	Self	4	Fov4 resistance selection
SJ10	Self	2	Fov4 resistance selection
SA x SA	Cross	12	Creation of new F_1s
SA x NM or MS	Cross	12	Creation of new F_1s
PS x SA	Cross	9	Creation of new F_1s
SJ10 x SA	Cross	8	Creation of new F_1s

In 2015 we added 207 new accessions from the USDA-ARS collection that were increased in Lubbock Texas, and 37 (17.5%) were selected (Table 4). Phil Roberts of UC Riverside provided 40 new accessions, with 4 (10%) being selected. In addition, 105 new crosses (F_1's) were created from these accessions for increasing and further evaluation.

Table 4. 2015 Total selections made for each objective group

Objective group	Total pedigree frequency
Pima collection	29
Upland collection	8
UC Riverside collection	4
Recurrent selection from 2014	14
Recurrent selection from 2013	8
RIL creations from 2014 F_1s	30
New F_1 creations	105
Total selections made	*207*

In all, 1155 entries have been evaluated in the field, 141 selections made (13% of total entries), 18 recurrent (2% of 2013-14 entries) and 142 crosses (F_1's) were produced. The 54 selections and the progeny from 2015 will be increased and evaluated in the greenhouse for reselection along with the recurrent selections and progeny from 2013 and 2014.

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