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RESEARCH ARTICLE

Evaluation of Medium Staple Cotton Genotypes for Tolerance to Jassids

Mutaviri Lovermore[1]*, Washington Mubvekeri[1]

[1]Department of agriculture research, innovation and specialist services, Zimbabwe

*Corresponding author: Mutaviri Lovermore: lmutaviri@gmail.com

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Abstract:

Tolerance of cotton genotypes to jassids attacks should be one of the on-going research programmes that Cotton Research Institute (CRI) should continue to carry on. This is because pests have a tendency of developing resistance to the use of insecticides which has become the most common and relied upon form of pest control in Zimbabwe's farmers. This can be done by fusion of tolerant traits which can be both genetic and morphological. Among the morphological traits are the openness, hairiness and small leaves. Openness reduces the density of leaf foliage thereby making difficult the moving of jassids, especially the nymphs that cannot fly, from one leaf to the next. Hairiness makes the jassid uncomfortable getting into contact with the hairy cotton due to their soft body tissue. Other traits like nectariless, gossypol content, reduced pubescence, tannins and trichome densities are genetic traits that increases varietal resistance to jassids attack on cotton. Fourteen medium staple genotypes namely 562-00-9, 564-00-6, 566-99-23, 651-01-1, 665-01-3, 666-01-2, 668-01-2, 816-01-1, 833-01-3, 931-05-9, 937-05-4, 97-05-1, LV96-05-8, SO-99-9 and two released varieties CRI MS1(check) and Delmac (check) were evaluated for their tolerance to jassids population and damage for three seasons from 2018-19 up to 2020-21 at Chibuwe, CRI, Muzarabani, Shamva and Umguza. The experimental design used was a Square lattice (partially balanced and randomized blocks) replicated three times. Treatments 97-05-1, 937-05-4, 562-00-9 and 666-01-2 were the best performing genotypes in terms of jassid resistance in most sites and seasons

Keywords: Resistance, Hairiness, Genotypes, Jassids, Tolerance, Pubescence, Insecticides

Introduction

Jassids, *Amrasca biguttula*, are among the major problem pests of cotton. There are various ways through which cotton pests, including jassids, can be managed. Such methods as biological control, use of pesticides, Integrated Pest Management (IPM) and the use of tolerant/resistant varieties are the most commonly used ones. The extensive use of insecticides may result in the health hazard problems, resistance development in insects, resurgence of secondary pest, environmental pollution and interruption of natural balance

(Khalil et al.,[1]). Despite the fact that farmers are over reliant on the use of chemicals (chemical control) in pest control, the use of tolerant or resistant varieties is of paramount importance as they tend to derive more benefits from this method. Pest infections or infestations often represent one of the largest risks to crop yields (Koul and Cuperus,[2]). Jassids suck the cell contents of the foliage and cause discoloration, drying out and eventually death of the plant (Vincezo and Serge,[3]). Famers mostly depend on the use of chemical use in pest control because of their prompt action (Soomro et al,[4]). In Zimbabwe, most pest control investments are especially targeted at chemicals. However, the effectiveness of resistant varieties in containing the destructive effects of various cotton pests is unquestionable (El-Zik and Thaxton,[5]). Also, conventional pesticides do not provide the intended control of sucking pests and leafhoppers (Keerthivarman et al.,[6]). This research area is also important as most farmers in cotton growing regions of the country rely on cotton as a cash crop for revenue generation. Sucking insect pests reduce the plant vigor by sucking sap from the leaves and other tender parts of cotton (Mansoor et al,[7]). Where jassids population exceed threshold levels, judicious and responsible use of insecticides should be considered (AgriBot,[8]). The fruiting capacity of the infested plants is seriously affected and heavy infestation causes death of young plants (Vennila et al.,[9]). The objective of the study was to evaluate cotton genotypes in respect of their tolerance to jassids.

Materials and methods

The field experiment was carried out at 5 different cotton growing locations of the country.

Experimental locations and design

The experiment to determine the effect of jassids on advanced cotton genotypes was conducted at Chibuwe in Manicaland province, CRI in Kadoma which is in Mashonaland West Province, Muzarabani in Mashonaland central province, Shamva Rural community also in Mashonaland central province and Umguza which is in Matebeleland province. The experiment was laid out in a partially balanced square lattice design with three replications.

Treatments

Treatments comprised of 16 cotton genotypes that were derived from the Medium Staple Breeding program. Of these 16 genotypes, only two namely CRI MS1 and Delmac were the check varieties. The genotypes were as shown by table 1 below:

Table 1: Treatments

TRT	TREATMENT NAME
1	562-00-9
2	564-00-6
3	566-99-23
4	651-01-1
5	665-01-3
6	666-01-2
7	668-01-2
8	816-01-1
9	833-01-3
10	931-05-9
11	937-05-4
12	97-05-1
13	LV96-05-8
14	SO-99-9
15	CRI MS1 (check variety)
16	Delmac (check variety)

Experimental measurements

Scouting was done for both jassid counts and damage. Twenty four plants were scouted for jassids witin each replication. However, no spraying was done even in situations where the jassid counts would reach their threshold of 36 out of the 24 scouted plants. This was because most of the insecticides that control other pests also controlled the jassids and spraying would compromise on the experiment's results. An example is Acetamiprid 20SP which controls aphids but also controls jassids. Again, the tolerance capabilities of the genotypes would not be fully expressed if they were to be assisted by the use of synthetic insecticides.

The damage by jassids was scored using the scoring system as shown by table 2 below

Table 2: Jassids damage scoring System

Score	Description
0	No jassids damage and no jassids present on the leaf
1	No signs of damage but jassids are present
2	Leaf showing yellow margins due to jassids
3	Yellowing spread over the whole leaf
4	Leaf showing signs of reddening
5	Leaf is all red

Plots size

Each plot had a gross area of $25m^2$ (5rows x 5m) and a sampling area of $9m^2$ (3 rows x 3m).

Results and discussion

Table 3: Effect of Cotton Genotypes on Jassids counts

TRT	Chibuwe			CRI			Muzarabani		UMGUZA			Shamva Rural		
	2018/19	2019/20	2020/21	2018/19	2019/20	2020/21	2018/19	2019/20	2018/19	2019/20	2020/21	2018/19	2019/20	2020/21
1	12.50	8.83	12.00	3.52	1.01	14.26bc	18.33g	- - -	10.07a	8.58abc	8.75	24.22bcd	36.00	6.82c
2	10.75	10.50	5.17	3.04	0.98	12.26abc	9.44cde	- - -	9.73a	11.08bc	8.75	27.22d	32.56	3.59ab
3	7.25	8.58	13.00	2.22	1.03	13.96abc	3.44a	- - -	6.40a	9.92abc	7.83	22.44abcd	36.78	3.22ab
4	9.75	8.83	5.50	3.37	1.06	14.26bc	14.67f	- - -	12.47ab	6.67a	8.83	25.89cd	39.22	3.00ab
5	11.33	14.58	9.83	3.00	1.15	8.85a	11.78de	- - -	11.00a	9.75abc	7.92	14.44a	32.44	3.07ab
6	11.25	6.08	4.50	3.14	1.15	11.15ab	12.11ef	- - -	6.20a	7.50a	11.42	23.44abcd	48.67	4.85bc
7	11.08	8.17	11.00	3.99	0.87	10.44ab	10.22de	- - -	9.40a	11.25bc	6.92	27.11d	46.00	3.74ab
8	13.50	10.50	7000	4.07	1.28	12.52abc	11.56de	- - -	10.13a	9.42abc	8.00	19.56abcd	54.78	1.96a
9	12.42	12.25	10.17	2.78	1.12	13.07abc	10.89de	- - -	12.20ab	11.92c	6.92	17.00abc	47.33	3.59ab
10	10.00	10.50	10.00	4.82	1.23	13.22abc	11.78de	- - -	9.33a	9.50abc	6.92	17.33abc	26.33	2.04a
11	11.67	8.58	11.58	1.93	1.18	10.85ab	6.78bc	- - -	6.33a	8.58abc	7.33	15.33ab	36.78	2.22a
12	8.00	10.42	7.25	3.63	1.45	11.15ab	5.00ab	- - -	9.87a	7.92ab	6.67	20.33abcd	17.78	3.85ab
13	11.00	7.08	9.42	4.15	1.35	16.41c	10.00de	- - -	18.27b	9.83abc	6.50	19.44abcd	24.56	1.59a
14	12.08	11.08	9.83	3.52	1.05	16.67c	10.56de	- - -	10.40a	10.00abc	10.50	24.44bcd	51.22	2.67ab
15	10.25	12.83	10.92	1.89	1.23	13.56abc	8.78cd	- - -	7.80a	11.17bc	8.83	17.11abc	37.78	1.96a
16	10.58	11.17	6.17	3.26	1.32	13.89abc	10.78de	- - -	8.00a	10.08abc	6.83	26.56d	42.78	3.30ab
Grand Mean	10.84	10.01	8.96	3.3	1	12.91	10.4	- - -	9.85	9.57	8.06	21.4	38.19	3.22
p-Value	0.500	0.089	0.303	0.479	0.738	0.057	<.001	- - -	0.049	0.048	0.061	0.012	0.195	0.004
Se	1.616	1.641	2.389	0.81	0.5	1.502	0.91	- - -	0.308	1.012	1.75	2.69	8.462	0.732
CV (%)	25.8	28.4	46.2	42.7	30.4	20.1	15.3	- - -	17.0	18.3	21.8	21.8	28.5	17.3

Effects of genotypes on jassid counts

There were no significant differences for jassid counts for all the three seasons at Chibuwe, for 2018-19 and 2019-20 for CRI, 2020 – 21 for Umguza and 2019-20 for Shamva. Significant differences were noted in 2020-21 for CRI, 2018-19 for Muzarabani, 2018-19 and 2019-20 for Umguza while for Shamva, 2018-19 and 2020-21 seasons showed significant differences. In 2018-19 season, treatment 566-99-23 had the lowest jassid populations. This was comparable to 97-05-1. 566-99-23 also had the lowest jassid counts in the same season at Umguza while at Shamva 665-01-3 had the lowest number of jassids. Muzarabani did not have results for 2019-20 because of poor crop germination leading to the trial being written off. At Umguza, 651-01-1 had the lowest jassid counts in 2019-20 season. This was comparable to almost all the treatments except 564-00-6 and 833-01-3. For 2020-21 season, 665-01-3 had the lowest counts at CRI which was the same scenario at Shamva although at Shamva, this could be comparable to all other treatments except 562-00-9

Table 4: Effect of Cotton Genotypes on Jassids Damage

TRT	Chibuwe			CRI			Muzarabani		UMGUZA			Shamva Rural		
	2018/19	2019/20	2020/21	2018/19	2019/20	2020/21	2018/19	2019/20	2018/190	2019/20	2020/21	2018/19	2019/20	2020/21
1	15.58	14.5	5.58cde	2.74cd	0.7	6.67c	3de	- - -	5.13	8.1a	10.67	3.33f	14.8	0.96
2	13.67	14.1	4.42bcd	2.04abcd	0.8	7.63bc	3de	- - -	6.13	10.8ab	8.00	2.44cde	15.2	0.74
3	10.83	12.5	6.75e	2.22abcd	0.8	8.78c	1.67b	- - -	6.07	12.1bc	10.08	1.67ab	16.7	0.67
4	13.5	10.3	3.83ab	3.11cd	0.8	8.63c	3.67f	- - -	8.27	12.5bc	10.42	2.56cdef	16.4	0.93
5	13.08	14.8	4.92bcd	1.96abc	0’7	6.85abc	3.11e	- - -	5.07	11.2ab	9.75	1.89abc	16.2	0.74
6	14.75	9.3	2.67a	2.59bcd	0.6	8.00bc	3de	- - -	5.67	12.8bc	9.42	2abcd	15.3	0.74
7	13	10.6	5.42bcde	3.22cd	0.4	7.96bc	2.33c	- - -	6.07	12.0bc	9.83	3.22ef	17.9	0.74
8	15.08	10.7	4.83bcd	3.22d	1.0	7.93bc	3.11e	- - -	6.6	12.3bc	11.33	2.67def	16.7	0.52
9	14.83	15.6	4.83bcd	2.26abcd	0.6	7.15abc	3.22e	- - -	5.47	14.8c	7.58	2abcd	15.9	0.67
10	14.25	16.0	4.50bcd	2.89cd	0.9	6.89abc	3.11e	- - -	6.87	11.6bc	8.58	2.11abcd	11.1	0.63
11	15.42	14.3	6.00de	1.3a	0.9	5.48abcd	1a	- - -	5.53	12.6bc	9.50	1.56a	14.3	0.52
12	12.5	12.6	4.17abc	2.11abcd	0.8	6.26abcd	1.11a	- - -	6.8	12.1bc	8.50	1.89abc	6.2	0.74
13	14.58	15.1	5.58cde	2.78cd	0.8	7.26ab	3.22e	- - -	7.4	10.4ab	11.17	2.33bcd	11.2	0.67
14	14.25	15.8	5.67cde	2.59bcd	0.6	7.52a	3.33ef	- - -	5.53	13.7bc	8.92	2.11abcd	16.2	0.78
15	14.25	14.8	4.75bcd	1.67ab	1.0	7.52a	2.56c	- - -	4.4	12.3bc	8.75	2.11abcd	15.2	0.52
16	18.17	14.9	4.58bcd	2.74bcd	0.8	6.96a	2.67cd	- - -	4.8	11.0ab	10.42	3.22ef	19.4	0.70
Grand Mean	14.23	13.49	4.91	2.47	0.77	7.47	2.69	- - -	5.99	11.89	9.56	2.32	14.93	0.71
p-Value	0.637	0.457	0.001	0.043	0.984	0.034	<.001	- - -	0.315	0.027	0.088	<.001	0.266	0.148
Se	0.2387	2.159	0.500	14.5	0.281	0.601	0.0388	- - -	0.1882	0.980	1.173	0.0799	2.750	0.106
CV (%)	11	27.7	17.6	20	23.4	13.9	3.9	- - -	13.5	14.3	15	8.5	24.7	25.8

Effect of cotton genotypes on jassids damage

Significant differences for jassid damage were noted in 2020-21 at Chibuwe, 2018-19 at Muzarabani, 2019-20 at Umguza and 2018-19 for Shamva. Treatment 666-01-2 had less damage on most seasons on all sites except for 2018-19 at Umguza. Muzarabani and Shamva had p values of <.001 for jassid damage in 2018-19 season. Treatment 562-00-9 had almost similar lesser damage level to 666-01-2 across all the season on all the sites. However, 937-05-4 had the least damage of all the treatments in all the sites though it was comparable to the two already mentioned except only in 2019-20 season at Umguza. But even at Umguza, it was comparable to all the other treatments in this 2019-20 season. Treatment 97-05-1 also had less damage implying good resistance to jassids attack

According to Shiao et al.[10], leaf hairiness has a significant role in the deterrence of pests especially jassids and sucking pests. Genotypes 937-05-4 and 97-05-1 had statistically similar damage levels across the seasons. This is possibly due to the fact that they had more hairs than other genotypes. The season 2019/20 recorded the highest damage across all the sites except at CRI. However, there were no significant differences among the genotypes in this season except at Umguza. The highest damage symptoms where leaf reddening was the major leaf colour were identified at Shamva Rural. All treatments' leaves turned red especially during boll maturation stage from late February to end of April due to both nymph and adult jassids attacks. The damage by jassids is by puncturing the epidermis and veins with their needle like proboscis and suck in the plant sack that contains a lot of sugars (Rajendran and Burange [11])

Conclusion

Treatment 97-05-1 and 937-05-4 had the best jassid resistance as is indicated by the lowest damage levels across seasons in almost all the sites. This was followed by 937-05-4 with the exception of only in 2019-20 season at Umguza where it was comparable to most treatments with higher damage levels. 562-00-9 and 666-01-2 had better and similar jassid resistant results across seasons and sites. The treatments 97-05-1, 937-05-4, 562-00-9 and 666-01-2 should be released and used for their jassid resistant levels. They should be grown in areas where jassids are a major threat to cotton production. This will cut on the farmer's cost of pest management as there will be a reduction in the use of insecticides such as synthetic pyrethroids. It also improves on both human and environmental health. This is because farmers' contact with insecticides is likely going to be reduced due to minimum use. Genotype 97-05-1 should especially be crossed with jassid susceptible varieties but good in other traits like yield. This is because of its highest jassid resistance level. These genotypes can be stored for future crossing programmes.

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Author address:

Cotton Research Institute
P. Bag 765
Kadoma
Zimbabwe

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