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# Artificial screening and inheritance studies on resistance to jassid (*Amrasca devastans*) in *Gossypium hirsutum* L.

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**Abstract**

**Studies on artificial screening of 13 *Gossypium hirsutum* lines and 30 hybrids were undertaken to identify the resistant genotypes for use in breeding programmes. From this study, it was found that KC 2 was highly resistant, Stoneville, DHY 286, Khandwa 2 were resistant and MCU 7 highly susceptible. Among the 30 hybrids, most of the hybrids came under resistant category. The genotypes KC 2, DHY 286 and Khandwa 2 were resistant to jassids and can be used as donors in breeding programmes to evolve jassid resistant varieties. Artificial screening for resistance to jassid (*Amrasca devastans*) was done in $F_2$ generation of fifteen crosses of upland cotton *Gossypium hirsutum*. The crosses KC 2 × MCU 7, KC 2 × MCU 12, Stoneville × MCU 5, Stoneville × MCU 7, Stoneville × MCU 12, DHY 286 × MCU 7, DHY 286 × MCU 12, Badnawar 1 × MCU 5, Badnawar 1 × MCU 7 segregated in the ratio of 3:1 for resistance and susceptiblity. However, the crosses KC 2 × MCU 5, DHY 286 × MCU 5 and Badnawar 1 × MCU 12, showed digenic segregation with epistasis, the actual segregation being 15:1, 9:7 and 13:3 respectively. The usefulness of the high yielding crosses, which segregated for 3:1 ratio, will pave way for selecting high yielding and jassid resistant varieties.**

**Key words:** *Gossypium hirsutum*, *Amrasca devastans*, jassid injury index, genetic studies, insect resistance

## Introduction

Cotton is grown in 34 million hectares in the world and in 9.0 million hectares in India alone. The present lint yield level in India is only 440 kg/ha. The yield level has been rising in India but still is below global average. This can be attributed to predominant rainfed cultivation and threatening pest complex. Among the sucking pests, jassids are the major pest of *hirsutum* cotton in India. The nymphs and adults of the leaf hopper, *Amrasca devastans* suck the sap from leaves and cause phytotoxic symptoms known as 'hopper burn' which results in complete desiccation of plants. Severe infestation leads to poor crop stand and stunted growth [1]. To fit in the integrated pest management component, it is necessary to breed jassid resistant varieties to minimize the use of insecticides.

The choice of an appropriate breeding procedure for the development of pest resistant varieties depends upon the nature and magnitude of genetic variation present in the base population. Information available on genetics of resistance to jassid in cotton requires to be updated to current scenario. Information on the complexity of inheritance of resistance in relation to modern genotypes and new biotypes of jassids is useful to the breeder in deciding the breeding methodology and the breeding strategies to be adopted. Diverse genes for resistance are needed to cope up with the development of new biotypes, to develop multiline varieties and to achieve regional deployment of genes. Marriott [2] and Sikka and Singh [3] reported that resistance to leaf hopper in cotton is controlled by dominant genes. Painter [4] identified two genes for jassid resistance in cotton. Mahal [5] on the other hand, observed quantitative differences for resistance to cotton jassid in Bhendi with a possible involvement of epistasis for this character. The present investigation was undertaken to identify resistant genotypes and to assess the nature of inheritance of resistance to cotton jassid *A. devastans* in *G. hirsutum* genotypes.

## Materials and methods

*Artificial Screening* : Artificial screening was conducted at the Screen House, Department of Cotton, TNAU, during 2000-2003. The experiment consisted of *G. hirsutum* lines *viz.*, KC2, SVPR 2, SVPR 3, SRT 1, Laxmi, Stoneville, DHY 286, Khandwa 2, Badnawar 1 and B 1007 and 30 hybrids. Seeds were sown in pots and for each entry five uniform plants were maintained. Screening was done by caging five pairs of leaf hopper for each plant. The third instar nymphs of leaf hoppers from a stock culture maintained were released on 25 day old plants and counts made on the increase in population and hopper burn injury up to 65 days of age.

Hopper burn injury was assessed as per the Indian Central Cotton Committee [6] methods and based on resultant symptoms of infestation. A jassid resistance index was calculated as proposed by Nageswara Rao [7].

*Inheritance studies*: The inheritance pattern of resistance in the lines *viz.*, KC 2, Stoneville, DHY 286 and Badnawar 1 was studied by crossing each resistant line with three standard varieties *viz.*, MCU 5, MCU 7 and MCU 12 during summer 2001. The hybrids were selfed to obtain $F_2$ population. The $F_2$ populations were evaluated for their resistance by artificial screening.

The individuals were grouped as resistant or susceptible based on the score value. The goodness of fit to Mendelian segregation of resistant and susceptible classes in the segregating population was tested by Chi-Square test [8].

## Results and discussion

*Gossypium hirsutum* parents and the hybrids were screened for hopper burn damage under screen house condition and jassid injury index was calculated and mean values are given in Table 1. Hybrids could be categorized into resistant, moderately resistant, susceptible and highly susceptible based on grade Index. All the thirteen parents recorded the mean jassid injury index lower than the susceptible check PRS 72 (Grade 4.0). Among the parents KC 2 recorded the lowest index value of 1.00 and came under resistant group, while Stoneville, Khandwa 2 and DHY 286 constituted the moderately resistant group, SVPR 3, *SVPR 2, Laxmi, SRT 1, Badnawar 1, B 1007, MCU* 5 and MCU 12 were susceptible and MCU 7 was in highly susceptible group.

**Table 1.** Mean jassid injury index of parents and hybrids

| Parents | Jassid injury index | Hybrids | Jassid injury index | Hybrids | Jassid injury index |
|---|---|---|---|---|---|
| KC 2 | **1.00** | KC 2 × MCU 5 | **1.30** | Stoneville × MCU 5 | 1.50 |
| SVPR 2 | 2.30 | KC 2 × MCU 7 | 1.5 | Stoneville × MCU 7 | 1.64 |
| SVPR 3 | 2.15 | KC2 × MCU 12 | 1.6 | Stoneville × MCU 12 | 1.33 |
| SRT 1 | 2.30 | SVPR 2 × MCU 5 | 2.15 | DHY 286 × MCU 5 | 1.48 |
| Laxmi | 2.30 | SVPR 2 × MCU 7 | 2.15 | DHY 286 × MCU 7 | 1.72 |
| Stoneville | 1.60 | SVPR 2 × MCU 12 | 2.12 | DHY 286 × MCU 12 | 1.65 |
| DHY 286 | 2.00 | SVPR 3 × MCU 5 | 2.18 | Khandwa 2 × MCU 5 | 1.72 |
| Khandwa 2 | 2.00 | SVPR 3 × MCU 7 | 2.28 | Khandwa 2 × MCU 7 | 3.1 |
| Badnawar 1 | 2.80 | SVPR 3 × MCU 12 | 1.78 | Khandwa 2 × MCU 12 | 2.0 |
| B 1007 | 2.40 | SRT 1 × MCU 5 | 2.0 | Badnawar 1 × MCU 5 | 1.6 |
| MCU 5 | 2.15 | SRT 1 × MCU 7 | 1.8 | Badnawar 1 × MCU 7 | 2.0 |
| MCU 7 | **3.30** | SRT 1 × MCU 12 | 2.0 | Badnawar 1 × MCU 12 | 1.8 |
| MCU 12 | 2.30 | Laxmi × MCU 5 | 2.0 | B 1007 × MCU 5 | 2.12 |
| PRS 72 (check) | **4.00** | Laxmi × MCU 7 | 2.25 | B 1007 × MCU 7 | 2.25 |
| | | Laxmi × MCU 12 | 2.0 | B 1007 × MCU 12 | 1.70 |
| **Mean (Parents)** | **1.98** | | | **Mean (Hybrids)** | **1.89** |
| **CD at 5%** | **0.80** | | | **CD at 5%** | **0.29** |

Among hybrids, KC 2 × MCU 5, KC 2 × MCU 7, KC 2 × MCU 12, SVPR 3 × MCU 12, SRT 1 × MCU 5, SRT 1 × MCU 7, SRT 1 × MCU 12, Laxmi × MCU 5, Laxmi × MCU 7, Laxmi × MCU 12, Stoneville × MCU 5, Stoneville × MCU 7, Stoneville × MCU 12, DHY 286 × MCU 5, DHY 286 × MCU 7, DHY 286 × MCU 12, Khandwa 2 × MCU 5, Khandwa 2 × MCU 7, Khandwa 2 × MCU 12, Badnawar 1 × MCU 5, Badnawar 1 × MCU 7, Badnawar 1 × MCU 12, B 1007 × MCU 5, B 1007 × MCU 7, B 1007 × MCU 12 fell under moderately resistant group, while Khandwa 2 × MCU 12 was grouped in highly susceptible category.

From this study KC 2, DHY 286 and Khandwa 2 found to be resistant to jassid can be used as donors in breeding programmes to evolve resistant varieties. The resistance in Stoneville and susceptibility of MCU 5 were confirmed earlier [9]. Nevertheless all the 13 genotypes recorded the mean injury index less than the susceptible check PRS 72. Malik and Nandal [10] and Ali [11] also studied the development of symptoms due to infestation of cotton jassid under glasshouse experiments. From the above study the genotypes found resistant to jassid can be used in the breeding programme to evolve jassid resistant high yielding varieties.

*Inheritance studies*: The population belonging to each $F_1$ was grouped into two classes *viz.*, resistant (jassid injury index 0.1-2) and susceptible (jassid injury index (2.1-4.0). The goodness of fit to the Mendelian segregation into resistant and susceptible groups in the segregating population based on Chi-square test is presented in Table 2. The $F_2$ generation of KC 2 × MCU 7, KC 2 × MCU 12, Stoneville × MCU 5, Stoneville × MCU 7, Stoneville × MCU 12, DHY 286 × MCU 7, DHY 286 × MCU 12, Badnawar 1 × MCU 5, Badnawar 1 × MCU 7 segregated in the ratio of 3:1 for Resistance and Susceptiblity. The crosses KC 2 × MCU 5, DHY 286 × MCU 5 and Badnawar 1 × MCU 12, showed

**Table 2.** Segregation pattern in $F_1$ generation for jassid resistance

| Cross combination | Resistant plants | Susceptible plants | Theoretical ratio | $\chi^2$ value | Probability |
|---|---|---|---|---|---|
| KC 2 × MCU 5 | 118 | 12 | 15:1 | 1.97 | 0.2-0.1 |
| KC 2 × MCU 7 | 70 | 20 | 3:1 | 0.37 | 0.7-0.5 |
| KC 2 × MCU 12 | 76 | 23 | 3:1 | 0.16 | 0.7-0.5 |
| Stoneville × MCU 5 | 60 | 22 | 3:1 | 0.14 | 0.8-0.7 |
| Stoneville × MCU 7 | 50 | 18 | 3:1 | 0.08 | 0.8-0.7 |
| Stoneville × MCU 12 | 54 | 17 | 3:1 | 0.04 | 0.9-0.8 |
| DHY 286 × MCU 5 | 47 | 27 | 9:7 | 1.59 | 0.3-0.2 |
| DHY 286 × MCU 7 | 39 | 16 | 3:1 | 0.49 | 0.5-0.3 |
| DHY 286 × MCU 12 | 53 | 15 | 3:1 | 0.31 | 0.7-0.5 |
| Badnawar 1 × MCU 5 | 49 | 15 | 3:1 | 0.08 | 0.8-0.7 |
| Badnawar 1 × MCU 7 | 36 | 14 | 3:1 | 0.24 | 0.7-0.5 |
| Badnawar 1 × MCU 12 | 58 | 8 | 13:3 | 1.90 | 0.2-0.1 |

a digenic segregation, the actual segregation ratios being 15:1, 9:7 and 13:3 respectively.

The study of inheritance of jassid resistance is an important criterion in advancing the progenies for further filial generations. In crosses KC 2 × MCU 7, KC 2 × MCU 12, Stoneville × MCU 5, Stoneville × MCU 7, Stoneville × MCU 12, DHY 286 × MCU 7, DHY 286 × MCU 12, Badnawar 1 × MCU 5 and Badnawar 1 × MCU 7 a monogenic inheritance with simple dominance recessive relationship was noticed. The crosses would yield fruitful results in obtaining high yielding and jassid resistant genotypes and handling of these populations is also very easy. A duplicate dominant genic control leading to a 15:1 ratio was noticed in the cross KC 2 × MCU 5. As most of the progenies will be resistant in these crosses, careful selection of segregants with double dominant alleles has to be exercised to achieve stable resistance and high yield. In the cross Badnawar 1 × MCU 12, a dominant-recessive epistasis leading to 13:3 ratio was realized. This is a complicated cross and one must pay greater attention to eliminate the undesirable susceptible combinations. In the cross DHY 286 × MCU 5 resistance and susceptible plants segregated in the ratio of 9:7. As this cross is also a desirable combination for yield and related characters, isolation of homozygous double dominant segregants must be carefully resorted to identify progenies combining high yield and resistance. Although the study of backcross generations would have given a better understanding of the inheritance rather than those obtained from $F_2$s alone, there is every possibility of isolating desirable segregants from crosses controlled by single dominant genes.

Work in India, using the cross (920 Cambodia × 58 F), suggested that resistance to jassids was conditioned by a single factor difference, resistance being dominant [4]. Sikka and Singh [3] reported a monogenic difference between resistant and susceptible varieties in some cases, while in others digenic segregation was met with. On the other hand, Mahal [12] observed quantitative differences for resistance to cotton jassid in *bhendi* with a possible involvement of epistasis for this character.

KC 2 has interacted with a single pair of genes for resistance to jassids in MCU 7 and MCU 12, whereas the same KC 2 showed interaction of two pairs of independent genes with MCU 5 thus giving 15:1 for resistance and susceptibility. In case of Stoneville there was interaction for single gene pair, while DHY 286 and Badnawar 1 interacted differently with different varieties in terms of resistance. Based on this study the crosses which segregated for 3:1 ratio will be useful for selecting high yielding and jassid resistant varieties. The parent MCU 5, being a released variety with very good fibre properties, can be improved upon by suitable backcrossing programmes for incorporating jassid resistance so that the reconstituted variety will have better adaptability and economic advantage.

### References

1. **Narayanan S. S. and Singh P.** 1994. Resistance to *Heliothis* and other serious insect pests in *Gossypium* spp.- a review. J. Indian Soc. Cott. Improv., **19**: 10-24.
2. **Marriot S.** 1943. Breeding jassid resistant cotton varieties. Agric. J., **57**: 204-206.
3. **Sikka S. M. and Singh A.** 1953. Inheritance of jassid resistance in some upland American cottons. Indian Cott., Gr. Rev., **7**: 113.
4. **Painter R. H.** 1958. Resistance of plants to insects. Ann. Rev. Entomol., **3**: 267-290.
5. **Mahal M. S., Lal H. and Singh R.** 1991. Standardization of a technique for screening okra germplasm for resistance against cotton jassid, *Amrasca biguttula biguttula* (Ishida). 1. Development and survival of nymphs. J. Insect Sci., **4**: 135-137.
6. **Indian Central Cotton Committee.** 1960. Cotton in India - monograph. Vol. II. ICCC, Bombay, pp 217-300.
7. **Nageswara Rao P.** 1973. An index for jassid resistance in cotton. Madras Agri. J., **60**: 264-266.
8. **Stansfield W. D.** 1969. Theory and Problems of Genetics. McGraw Hills Book Co., Inc., New York., USA: 150.
9. **Khurana A. D.** 1989. Screening of cotton germplasm for susceptibility to Jassid, *Amrasca biguttula biguttula* Ishida. Cotton Dev., 41-43.
10. **Malik V. S. and Nandal A. S.** 1986. Screening of cotton varieties/germplasm for resistance against cotton jassid, *Amrasca biguttula biguttula* (Ishida) and pink boll worm, *Pectinophora gossypiella* (Saunders). Haryana Agric. Univ. J. Res., **16**: 290-293.
11. **Ali M. I.** 1990. The development of symptoms due to attack of the cotton jassid. *Amrasca biguttula* (Shir.) Bangladesh J. Zool., **18**: 211-214.
12. **Mahal M. S.** 1978. Inheritance of resistance in Okra (*Abelmoschus esculentus* L.) to the cotton jassid (*Amrasca biguttula biguttula* Ishida). Unpubl. Ph.D. Thesis, Punjab Agricultural University. Ludhiana.