

SCREENING OF SOME SORGHUM LINES FOR  
RESISTANCE TO SHOOT FLY  
[*Atherigona soccata* Rond]

**A Thesis submitted to the**

**MAHATMA PHULE KRISHI VIDYAPEETH**

[ AGRICULTURAL UNIVERSITY ]

**RAHURI (DIST. AHMEDNAGAR)**

( MAHARASHTRA STATE )

**In partial fulfilment of the requirements for the degree of**

*Master of Science (Agriculture)*

**in**

*AGRICULTURAL ENTOMOLOGY*

**By**

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**DEPARTMENT OF AGRICULTURAL ENTOMOLOGY**

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**AUGUST, 1979**

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C E R T I F I C A T E

This is to certify that the thesis entitled "SCREENING OF SOME SORGHUM LINES FOR RESISTANCE TO SHOOT FLY (Atherigona soccata Rond.)" submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, District: Ahmednagar (Maharashtra) in the partial fulfilment of the requirements for the degree of MASTER OF SCIENCE (AGRICULTURE) in AGRICULTURAL ENTOMOLOGY, embodies the results of a piece of bona-fide research work carried out by Shri. BOTE NANASAHEB NIVRUTTIPIAO under my guidance and supervision. No part of the thesis has been submitted for any other degree or publication.

Rahuri,

Dated: 31 August, 1979

  
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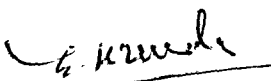
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C E R T I F I C A T E

Certified that the thesis entitled "SCREENING OF SOME SORGHUM LINES FOR RESISTANCE TO SHEET FLY (Atherigona soccata Rond.)" submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra), in partial fulfilment of requirements for the degree of MASTER OF SCIENCE (AGRICULTURE) in AGRICULTURAL ENTOMOLOGY embodies the results of a piece of bona-fide research carried out by Shri. BOTE NANASAHU NIVRUTTIRAO under the guidance and supervision of Prof. R.N. Pekharkar, Associate Professor, Department of Agricultural Entomology, MPKV, Rahuri and that no part of the thesis has been submitted for any other degree or publications.

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*Bothe*  
(Manasaheb N. Bothe)

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# i. Introduction

## CHAPTER- I

### I N T R O D U C T I O N

Sorghum ( Sorghum bicolor (L.) Moench ) occupies an important position among the food crop of the world. In the Indian union, it is a major staple food and fodder crop. The large sector population of the country depend on jowar for their daily diet. According to all India estimates, it is grown over an area of about 18 million hectares with the annual production of 10 million tonnes of grain. In Maharashtra, it has a pivotal position among the food crops and is annually cultivated over an area of about 63.40 lakh hectares. Even though, India has the largest area under this crop, the yield per hectare (550 kg/ha) is far low as compared to other countries. The yield of the crop in Maharashtra stands almost at equal level to the national averages (Anonymous, 1978).

Among the various reasons for low yield, the losses caused by pests is the important one. Although 35 insect and non-insect pests have been recorded on sorghum in the state, the shoot fly ( Atherigona seccata Rondani) and stem borer (Chilo partellus Swinhoe) are the important ones. The aphids and dephacids are of course, common but these can be controlled by suitable chemicals. The formers being internal feeders are difficult to control successfully, even with the application of most potent insecticides.

The shoot fly was among the minor pests till the introduction of high yielding hybrid varieties. These were

found to be highly susceptible to the attack of the shoot fly as compared to traditional local varieties. In fact, these hybrids have been accepted by all the cultivators, even though, they are quite aware of their yielding potential. It is felt that the susceptibility of these varieties is probably the root cause of this non-acceptance.

Efforts are, therefore, underway to evolve suitable and economic control measures to bring the pest under check. Some of the insecticides have proved to be effective but their use has many limitations. Among these, the cost involved in the use of chemicals and the hazards associated in their use are the most important ones. The entomologists are therefore, on the constant look out of other measures.

To grow resistant varieties is the most profitable and permanent solution of a pest problem. This is much more important in crop like sorghum which is cultivated over a large scattered area and the margin of profit is very narrow.

A large number of varieties have been tested by several workers and under the All India Coordinated Sorghum Improvement Project. Some of the lines are also reported to be quite promising. Although the work of testing resistance to shoot fly has been already initiated several new entries with desirable characters are continuously introduced. Before these could be tested on large scale, it is necessary to test their reaction to the attack of shoot fly.

It was, therefore, proposed to test some of the lines for their resistance to shoot fly. Twentyone entries of sorghum obtained from the Sorghum Breeder, All India Coordinated Sorghum Improvement Project, Rahuri were screened under field conditions both in kharif and rabi seasons. In addition to the observations of their reaction to the attack of shoot fly, data regarding stem borer infestation were also recorded since this is an also important tissue borer of the crop. Varieties tolerant to both these pests will be ideally suited for future breeding programme and for large scale cultivation.

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ii. Review of  
Literature.

## CHAPTER- II

### REVIEW OF LITERATURE

Although growing crop varieties resistant to pests and diseases was a good old practice, the information on their differential behaviour to insect attack and their relationship is available on record for not more than 150 years. The literature accumulated during these years is voluminous and widely scattered. It is beyond the scope of the present investigation to review the literature on varietal resistance in crop plants. The review of literature presented in this chapter is therefore restricted to the varietal resistance in sorghum to shoot fly (Atherigona soccata Rondani) and stem borer (Chilo partellus Swinhee ).

#### I. Shoot fly (Atherigona soccata Rond.)

The shoot fly or cholan fly was firstly described and named by Rondani as early as in 1871. Malloch (1923) identified this fly as Atherigona indica. Although the pest was recorded in India in the year 1907 at Pusa ( Fletcher, 1914; Ballard and Ramchandrarao, 1923), the published literature shows that the research work on varietal resistance to the pest had taken impetus during the last two decades.

Ponnaiya (1951) screened 214 varieties of sorghum and reported that the attack of the pest in the 4th leaf stage was significantly less in resistant varieties like T-1 and N 47-3 as compared to the susceptible ones eventhough the eggs were laid in more or less equal numbers on all the

varieties. According to him, the early formation of irregularly shaped silica units on the fourth leaf sheath of the seedling appeared to be the factor responsible for resistance of a variety. He also noticed that the degree of susceptibility was not related to the lignification of plant cells.

Of the fortytwo varieties tested by Rao and Rao (1956), none was immune to shoot fly although M 47-3 and CO-2 were slightly tolerant. Jain and Bhatnagar (1962) screened 196 varieties and noted that the number of eggs laid per plant by shoot fly varied from one to eight. Generally less number of eggs were observed on resistant varieties than susceptible ones. They observed that although the eggs were laid on the first eight leaves of a plant, third and fourth leaves were mostly preferred for oviposition. Therefore, a positive correlation existed between number of eggs laid, leaf number and percentage infestation. The negative correlation was observed with plant height and number of days required to flower. They found that the varieties IS Nos.-1005, 1056, 1119, and 2245 were highly resistant to shoot fly.

Doggett and Majisu (1965) stated that sorghum variety 'Namotera' remained resistant as a result of its profusely tillering habit and ability to recover from early seedling attack. Blum (1965) screened 280 sorghum varieties from Indian material and reported M 35-1 as resistant to shoot fly. Out of 3883 varieties, from International collection tested by Thobbi (1966), 246 selections were tolerant to

shoot fly and IS Nos.-1082, 5533, 1034 and 1079 were observed to be promising.

Blum (1966) reported that forage sorghum hybrids grow at a more faster rate at seedling stage than RS-610 ( a dwarf variety) thus causing larger number of tillers to escape the damage from shoot fly, as compared to dwarf hybrids. He further (1967) evaluated five selections from Indian germ plasm and two susceptible varieties ( TX 7078 and RS-610), for resistance both under natural and artificial infestation conditions. Three selections including M 35-1 possessed a satisfactory rate of resistance controlled by three mechanisms viz., (i) non-preference for oviposition, (ii) avoiding the larval penetration through leaf sheath and (iii) resistance of tillers formed after destruction of growing apex. He (1967 a) further compared the reaction of ten forage hybrids with a grain hybrid sorghum and found that there was no difference in tillering capacity, but the rate of non-infested tillers was higher in the forage hybrids as compared to grain hybrids.

Vedamoorthy (1967) stated that the varieties possessing foliage with dull green colour and waxy bloom appearance were comparatively more susceptible than those possessing foliage with bright shiny green colour. Sharma (1968) found that few locally improved varieties were resistant and the parents of two hybrids (CSH-1 and Swarna ) were susceptible to stem fly. The varieties namely IS Nos.-1003, 1083 and 1054 showed

appreciable degree of resistance to stem fly.

Parameswarappa et al. (1968) reported that at Raichur, M 35-1 was observed to be resistant in early stage of growth because of vigorous growth, although later on the side tillers were heavily infested. They concluded that none of the varieties tested was completely resistant.

Blum (1968) stated that all the resistant varieties exhibited distinct lignified and thick walls of the cells which enclose the vascular bundles at the central whorl of young leaves. He reported that the density of silica deposit at the base of 1st, 2nd and 3rd leaf sheaths was much more in resistant varieties as compared to susceptible ones. He further (1969) studied the factors responsible for tiller survival in resistant varieties and reported that it was associated with lignified tissues at the central leaf whorl and a fast growth rate of tillers.

Krishnananda et al. (1970) screened 19 selected varieties and found that entries like CSH-1, IS-84, CSH-2 and CO-18 were highly susceptible and preferred more for oviposition than resistant varieties like IS Nos.-5666 and 5285. They observed that the flies always preferred third and fourth leaf for oviposition and noted maximum infestation during the third and fourth week after sowing.

Jotvani and Srivastava (1970) reported that the sorghum varieties IS Nos.-4522, 4776, 5210, 1061 and 1034 showed

high degree of resistance than the susceptible check Swarna. Jotwani et al. (1971) studied ovipositional preference of shoot fly in some promising sorghum lines. They concluded that non-preference in some lines varied with stage and growth of plant. The resistance against the pest observed under field conditions might partially be due to the non-preference for oviposition in these lines. The total number of eggs laid per plant was low in varieties IS Nos.-5801, 5655 (0.83/plant) followed by 5470, 4359 and 1034. The maximum number of eggs were observed on Swarna ( 5.73/plant). They showed that the number of eggs laid on the selected promising lines were significantly less than on the three susceptible checks (CSH-1, CSH-2 and Swarna ). In further studies, they screened highly promising sorghum lines for ovipositional response to the shoot fly. They observed 0.13 average number of eggs per plant in sorghum lines IS Nos.-5463, 5420, 4664, as against 1.36 and 1.46 eggs on susceptible checks CSH-1 and Swarna respectively. Thus, they reported that non-preference for oviposition was possibly a factor responsible for relatively less damage by shoot fly ( Jotwani et al., 1971a). Similar results were also obtained by Seto (1972).

Raghunath et al. (1972) screened sorghum lines for their resistance where in 'Neejola' seemed to be more susceptible than other varieties. They also reported that the low incidence in case of CBE-X, might be due to its initial vigorous growth.

A large portion of world germplasm of sorghum was screened

at several locations under the All India Coordinated Sorghum Improvement Project and also studies were undertaken from 1960 onwards on the mechanisms of resistance in sorghum to the shoot fly. It is reported that (a) field resistant varieties showed much higher damage under green house conditions, (b) preference and non-preference for oviposition was highly operative. Under the same project 41 lines were screened in the trials carried out at Hyderabad and Parbhani in the year 1971-72. All the promising lines showed significantly less dead hearts than the checks and number of eggs laid on promising lines was significantly less than on the susceptible check CSH-1 (Anonymous, 1971-72).

Twentyfour lines of sorghum resistant to shoot fly were tested for oviposition response during the kharif season, 1972. It was noticed that average number of eggs per 10 plants varied from 1.33 to 6.00 on resistant lines as compared to 12.00 in check Swarna. The percentage of dead hearts in selected lines varied from 8.44 to 30.21 as compared to check, Swarna (66.40 per cent). During the rabi season 1972, observations were recorded on oviposition, dead hearts, leaf colour, leaf surface, flowering date on 6 resistant lines and four high yielding parental lines. It was concluded that non-preference to oviposition was one of the major factors responsible for resistance to shoot fly under field conditions ( Anonymous, 1972-73).

The percentage of dead hearts was significantly higher

on exotic lines than on Indian varieties where flies were offered a choice for oviposition but were damaged equally when there was no choice for oviposition (Seto, 1974).

Dalvi (1975) screened thirtytwo and thirty varieties in khari and rabi seasons respectively. During khari, the percentage of dead hearts was minimum in R-24 and maximum in CSH-1. Maximum number of eggs was observed on IS-2445 and minimum in E-303. In rabi, the minimum percentage of dead hearts was recorded in M 35-1 and M 47-3, while the variety M 47-3 was the least preferred for eggs laying. He observed that the higher silica content of sorghum seedling reduced the shoot fly infestation. The maximum and minimum silica contents was noticed in the variety R-24 and 555 respectively.

Bapat et al. (1975) observed that cultivar 148 having pale green leaves was less susceptible, as compared to Swarna and CSH-4 which possessed deep green colour leaves and high NCM contents. Venugopal et al. (1975) screened 20 sorghum varieties and reported that none was highly resistant. All the varieties screened recorded more than 55.8 per cent per cent damage and variety 148 had the highest damage of 84.2 per cent.

Narayana (1975) studied 12 promising sorghum varieties for shoot fly resistance and indicated significant differences in preference for oviposition. In tolerant varieties, the average number of eggs deposited per plant was less than one whereas, 2.33 eggs per plant were found on susceptible ones. The percentage of infested plants of the entries tested

ranged from 29.6 (IS-5566) to 79.4 (CK 60-B) per cent. The initial infestation in resistant varieties was less than that in the susceptible varieties. In general, there was a lower average infestation at first week and maximum at second and third weeks. Thereafter, there was a sudden decrease in the fourth week after seedling emergence. The sorghum variety IS-5566 was more tolerant. Dwarf (slow growing) varieties were highly infested than the taller varieties except IS-1047. Sorghum varieties with glossy leaves and no waxy bloom coating were less preferred for oviposition. No differences in the specific site of oviposition was noticed in resistant or susceptible varieties. The tolerant variety IS-1054 possessed a distinct lignification and thickness of walls of cells enclosing the vascular bundles as compared to the susceptible variety IS-3922.

Sharma (1975) showed that the percentage of dead hearts was negatively correlated with seedling height, plant recovery and yield per plant. The number of tillers per 100 plants, the number of effective tillers, plant recovery and yield were positively associated with each others, indicating that tillering character contribute to yield rather than to shoot fly resistance. Lawrence *et al.* (1974-75) showed that the cultivars IS Nos.-1082, 3962, 5358, 5604 and 5633 showed a good level of non-preference for oviposition and tolerance to the attack of the pest.

In All India Coordinated Trials conducted at Delhi

in 1974-75, six entries were screened and it was observed that the number of eggs laid on promising lines was significantly less than on the susceptible check. All promising lines viz., IS Nos.-2123, 5469, 5604, 5801 and 8315 showed less dead hearts than the check. Similar results were obtained at Hyderabad, and it was reported that the pale green colour of leaves was possibly associated with the resistance ( Anonymous, 1975).

Shivpuje et al. (1976) showed that the tolerance level in six lines ranged from 34 to 44 per cent, while the rest of the lines ranged from 50 to 77 per cent. Thirteen lines showed the tolerance level upto 50 to 65 per cent while seven were highly susceptible having infestation of 62 to 82 per cent. Tolerant line PS-4 K showed shoot fly infestation level of 30 per cent. It was concluded that there is a possibility of selecting lines from Indian x Exotic crosses, having desirable agronomic characters and moderate levels of shoot fly tolerance.

Venugopal (1976 a) screened fourteen promising lines and observed that U-358 was the least preferred while five sorghum lines recorded more than 44 per cent damage. Of the fortytwo lines tested in kharif and 29 lines in rabi seasons, SPV-9 (35.7 per cent) showed comparatively less damage while it ranged from 40 to 92.2 per cent in other entries (Venugopal et al., 1976 b).

Sixty varieties were screened in coordinated trials in 1976-77 at various centres and it was observed that the

level of infestation was not similar at all the centres. But varieties like IS-5490 ( R. check), SPV-69, SPV-70, SPV-108, SPV-112, SPV-125, SPV-13, SPV-97, CSV-3 and E-302 were moderately resistant ( Anonymous, 1977).

Jadhav (1977) screened fortyfive entries in kharif and twentyseven in rabi seasons. Minimum percentage of dead hearts was observed in M 35-1 and maximum in CSH-1 in both the seasons.

Srivastava and Jotwani (1977) studied shoot fly resistance in sorghum lines under artificial infestation conditions and showed that the dead hearts in resistant lines ranged between 53.33 to 75.00 per cent as against 100.00 per cent in the susceptible check. Kundu et al. (1977) studied fifty sorghum derivatives obtained from crosses between high yielding and resistant varieties and recorded dead hearts ranging from 0 to 8.33 per cent in twenty lines. A line giving good results had genes contributed by M 35-1 or BP-53.

Bapat et al. (1977) tested fortyeight sorghum lines and entries viz., M 35-1, CS-3541, 168, P-69, 39-1 were found to be relatively less susceptible to the attack of shoot fly, in which the damage ranged between 18.33 to 29.83 per cent as compared to 58.55 per cent in susceptible check, CSH-1.

Taley et al. (1978) tested fortytwo entries including IS-5490 and CSH-1 as resistant and susceptible checks

respectively. The dead hearts on IS-5490 were 13.43 per cent while entries SPV-108, SPV-107, SPV-193, SPV-165 and SPV-104 were moderately resistant showing on an average 20 to 40 per cent dead hearts. They further studied 16 entries and observed that Aispuri (20.39%), P-37(28.23%), Maldandi (22.45%) and SPV-29 (28.75%) were moderately resistant to shoot fly.

Sadakathulla et al. (1978) screened 22 sorghum lines and observed that D-832 (3.09%) suffered the least shoot fly damage followed by SPV-13 ( 5.05%), D-244 (5.27%), E-303 (5.97%) and SPV-102 (6.74%), while M 35-1 was found free from dead hearts. They (1978) further studied fourtynine sorghum lines and reported that the entries SPV-99, SPV-193, IS-5604, SPV-190, SPV-101, SPV-110, SPV-97 and VCN-1 showed minimum per cent of dead hearts. Entry IS-5490 did not show any dead hearts while maximum infestation was recorded on variety SPV-126 (50.41%).

Sangappa et al. (1978) compared the performance of hybrid RSH with other hybrids and varieties, and indicated that the average number of eggs laid per plant for 21 days ranged from 1.8 to 4.06, while minimum eggs laying was observed in Muguthi variety ( 1.80/plant) followed by RSH-1, FR-169, CSH-8, CSH-6 and CSH-5. The local Muguthi was more resistant to shoot fly than other hybrids and varieties. The new hybrids RSH-1, CSH-8 and varieties Muguthi and FR-169 were highly resistant.

Jetwani (1978), in the technical report PL-480 project stated that average number of eggs laid per 10 plants varying from 1.33 to 6.00 in resistant lines as compared 12.00 checks. He further stated that there was no direct correlation between the number of eggs laid and percentage of dead hearts.

## II. Stem borer ( Chilo partellus Swinhoe )

The stem borer was firstly recorded by Swinhoe in 1884 and was put in the genus Craobug. Fletcher (1914), identified this species as Chilo simplex but later on Trehan and Butani (1950) named the same as Chilo zonellus.

Trehan and Butani (1949) tested six varieties of sorghum against Chilo zonellus S. and Sesamia inferens W. under field conditions and found that the attack of C. zonellus was more in kharif and less in rabi.

Kantikumar and Bhatnagar (1962) screened 1140 varieties of sorghum for resistance to sorghum stem borer and found that only seven varieties were completely free from attack of this pest. Dwarf and early varieties with thin stem, few narrow and short leaves, short and thin earhead, less grain weight and threshing percentage were comparatively more resistant than others. Types with white exposed seed, spreading earhead, and juicy stem were found to be highly resistant.

The sorghum varieties which were late and higher in sugar content were less damaged by stem borer than the early varieties with low sugar content. There was no association between the stem borer infestation and HCN content

(Swarup and Chaugule, 1962).

Sharma (1965) concluded that nutritive values of different sorghum varieties played a vital role on the survival and development of the pest. Hairy varieties were less preferred by the pest for oviposition and less number of larvae were able to establish on them and thus proved to be relatively resistant. He found that the varieties TSB and (512.2)-OP, were highly resistant while varieties 555 and Indore selection were highly susceptible.

Kalode and Pant(1966) reported that Babush, Hegari and Nyanjang varieties were highly susceptible while C-10-2, Sundhia were least susceptible to stem borer. They (1967) further studied that the early stage of plant appeared to be more suitable for larval development than medium and late stages.

Jetwani et al. (1971) screened 14 lines to the stem borer resistance in sorghum. The lines IS Nos.-5470, 4776, 5030, 4747, 1151, 1044, 4994, 1115, 1137, 4651, 1056, 4782 and 4552, were observed to be resistant as compared to susceptible check CSH-2.

The sorghum lines E-302 and E-303 showed high degree of resistance in trial, conducted at Delhi under All India Coordinated Sorghum Improvement Project (Anonymous, 1972-73). In another trial 50 lines were screened for borer resistance at different locations. Sorghum lines like IS Nos.-447, 769, 829 and 1135 were found to be resistant (Anonymous, 1972-73).

Jotwani et al. (1973) screened 24 promising lines of sorghum for resistance to stem borer. They found that eight lines viz., IS Nos.-4424, 4689, 4841, 4875, 4934, 5031, 8314 showed less leaf injury, dead hearts and stem tunnelling as compared to susceptible check CSH-1. They further (1974) stated that two sorghum entries viz., E-303 and E-302, were highly promising stem borer resistant lines.

Dalvi (1975) reported that CSH-1 showed the highest susceptibility to stem borer both in kharif and rabi seasons. The varieties E-302, E-303 were found to be more resistant. Sundararaju et al. (1976) screened twenty sorghum varieties and sixteen sorghum hybrids for stem borer incidence. They found that, the damage due to stem borer, ranged from 18.33 per cent to 46.66 per cent and least damage was recorded in SPV-3 (18.33%), SPV-8 (18.33%), CSV-6 (18.33%) and highest in SPV-13 (46.66%), while in hybrids it ranged from 25 per cent to 61.66 per cent. The lowest damage was observed in SPH-25 (25.00%) and the highest was noticed in SPH-4 (61.66%). They concluded that hybrid were more susceptible to the attack of stem borer than the varieties.

Jotwani et al. (1977) conducted three separate trials to select high yielding, borer resistant derivatives and suitable donor parents. Out of 60 selected derivatives from three crosses, 23 were showing a moderately high degree of borer resistance. The lines viz., SPH-30, P-151, SPH-14, SPV-60, VZM-2B, SPV-61, 447, SPV-84 and E-302 were selected for borer resistance.

Taley et al. (1978) tested sixteen entries for stem borer resistance and found that the entries E-302, E-303, SPV-29, Maldandi, SPV-13 and Aispuri were moderately resistant to stem borer showing stem tunnelling below 25 per cent. They further reported that, the entries SPV-185, E-303, SPV-138, SPV-187 proved to be resistant showing less than 10 per cent stem tunnelling. Entries SPV-181, SPV-101, SPV-106, CSH-1, SPH-77, SPH-78, SPV-125 and SPV-100 were moderately resistant to stem borer showing on an average 10 to 20 per cent stem tunnelling. The entries SPV-169, SPV-97 and SPV-135 showed a maximum stem tunnelling upto 50 per cent to 60 per cent.

Jotvani et al. (1978) screened seven highly promising lines of sorghum to determine their degree of resistance to stem borer. They found that except 447 and Swarna the entries E-302, E-303, U-358, P-151 and JP-37 showed high level of borer resistance. They concluded that a fairly high degree of borer resistance can be acquired by the derivatives developed between susceptible x resistant varieties.

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**iii. Material  
and  
methods**

## CHAPTER- III

### M A T E R I A L   A N D   M E T H O D S

Investigations into varietal resistance in sorghum to shoot fly ( Atherigona soccata Rond.) were carried out under field conditions at the Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri. Statistically designed field experiments for screening twentyone entries were conducted both in kharif and rabi seasons 1978-79.

The seeds of these lines were obtained from the Sorghum Breeder, M. P. K. V., Rahuri. The details of these experiments are given below.

#### I. Classification of sorghum entries

##### A) MS lines (female)

- 1    CK 60-B
- 2    1202 B
- 3    1258 B
- 4    36 B
- 5    2077-B

##### B) Restorer lines

- 6    IS-84
- 7    285
- 8    PD-3-1-11
- 9    1324
- 10    168
- 11    CB-3541

##### C) Tolerant lines

- 12    M 35-1
- 13    IB-5490

- D) **F<sub>4</sub> material**  
 14 SPV-102  
 15 SPV-104  
 16 SPV-115
- E) **F<sub>5</sub> material**  
 17 GM-1-5 x IS-3922(393)
- F) **Hybrid material**  
 18 CBH-1  
 19 CBH-5
- G) **Derived lines from M 35-1 x E. caudatum.**  
 20 HB-9  
 21 HB-11

## II. Details of the field experiments

Sr. No.	Particulars	Kharif	Rabi
1	Design used	Randomised block design	Randomised block design
2	Plot size-		
	a) Gross	3 x 5 metre	3 x 5 metre
	b) Net	2.7 x 4.5 metre	2.7 x 4.5 metre
3	Number of entries	21	21
4	Spacing	45 x 15 cm	45 x 15 cm
5	Date of sowing	20-7-1978	19-9-1978
6	Replications	Three	Three

The land was prepared as usual. Flat beds of 3 x 5 metre size were prepared and 3-4 seeds were dibbled at each hill at the spacing given above. Seeds were not treated with any insecticides. The sowing was purposely delayed than the recommended time, so as to ensure a definite shoot fly attack. All the recommended agronomical practices were carried out without giving any insecticidal application during the experimental period.

The fertilizers were used at the rate of 100 kg N, 50 Kg P and 50 kg K per hectare in both kharif and rabi seasons. Half the dose of N and full dose of P and K were applied at the time of sowing and remaining half dose of N was applied three weeks after sowing.

### III. Method of recording the observations

#### A) Shoot fly ( Atherigona seccata Rond.)

##### 1) Egg laying

The varietal resistance may be due to several factors, one of these is the preference for egg laying. Observations were therefore, recorded at five days interval starting from 7 days after sowing on the number of eggs laid on 20 randomly selected plants. Only freshly laid and unhatched eggs were counted. The observations were recorded upto 37 days after sowing. The data were tabulated and statistically analysed.

##### 11) Dead heart count

A usual method to assess the damage caused by shoot fly,

Q22

is to record dead hearts caused by its feeding. The method followed by Dalvi (1975) for dead heart count was adopted during these investigation. The total numbers of plants and those showing dead hearts were counted at each observation recorded at an interval of 7 days starting from 12 days after sowing and continued upto 37 days. Besides, at each observation the dead hearts counted at previous observations were subtracted to obtain the dead hearts caused during five days period between the two observations. Dead heart count in respect of mother shoots and tillers were recorded separately. The percentage infestation was worked out and subjected to angular transformation and the data were statistically analysed.

#### iii) Egg laying on tillers

These observations were recorded at five days interval starting from 22 days after sowing and continued upto 37 days. The number of eggs laid on 20 randomly selected tillers were recorded. Only freshly laid and unhatched eggs were recorded. The data were statistically analysed.

#### iv) Dead heart count on tillers

In these observations the total number of tillers and those showing dead hearts were counted. These observations were recorded at five days interval starting from 22 days after sowing and continued upto 37 days. The percentage infestation was worked out and subjected to angular transformation. The data were statistically analysed.

**B) Plant growth observations****1) Leaf breadth**

To determine the relationship between the leaf breadth and the reaction of the entries to the attack of shoot fly, observations were recorded on five randomly selected plants at five days interval starting from 17 days after sowing and continued upto 37 days. The fourth leaf was selected to record these observations since the eggs are usually laid on 3rd or 4th leaf. The data were statistically analysed.

**11) Number of leaves**

In order to study the correlation between leaf number and incidence of shoot fly, observations were recorded at an interval of six days starting from 12 days after sowing and continued upto 36 days. The number of leaves were counted in the experiment conducted in rabi season on 10 randomly selected plants and average number leaves per plant was worked out. The data were statistically analysed.

**C) Stem borer ( Chilo partellus Swinhoe )**

For recording observations on the intensity of infestation of stem borer, 5 plants were selected at random and up-rooted separately at the time of harvest. The method followed by Kalode and Pant (1966) was used for recording the observations.

**1) Height of plant**

Plant height was measured from the base of plant above the soil layer to the last fully opened leaf.

ii) The plant selected for above observations were split open longitudinally and examined for (a) number of larvae, (b) number of pupae, (c) number of tunnels, (d) stem length tunnelled and (e) number of internode attacked.

Out of these observations, the stem length tunnelled and number of internode attacked were converted into percentage and subjected to angular transformation while all the remaining observations were calculated on 5 plants basis. The data thus collected were statistically analysed.

C) Silica determination in sorghum entries

Djain and Pathak (1967) reported that high silica contents of rice plant showed less incidence of stem borer. To confirm whether it holds good with sorghum plant also, studies were conducted on estimation of silica content.

In rabi season eighteen entries were sown in small plots separately. The samples were taken at two stages, 4th leaf stage and 6th leaf stage by uprooting the plants. The soil contamination was strictly avoided. The root-crown and portion of leaf from the point of leaf sheath was removed. Thus the sample consisted of leaf sheaths and stems. The plant material was air dried for 8 days and then oven dried for 12 hrs at 70°C and ground into fine powder with the help of iron mortar and pestle.

Dalvi (1975) used the method of Toth et al. (1948) as described by Morten and Jutras (1974) to determine the silica content in the plants. Since this is time consuming,

the method suggested by Walkley (1942) was followed.

Digestion of the dried material was carried out in triacid mixture consisting of nitric acid, sulphuric acid and perchloric acid. One gram of finely ground air-dried sample of each entry was taken and transferred to 50 ml. Micro-kjeldahl digestion flask and 10 ml of nitric acid and 2 ml of mixture of equal volumes of sulphuric acid and perchloric acid was added to this. First brown fumes appeared which was followed by white fumes. Extra quantity of  $\text{HNO}_3$  was added when the content of the flask turned black thereby showing insufficient amount of acid to digest organic matter. The digestion was continued on low heat for 5 to 10 minutes. Then the temperature was raised to the full heat of the plate, so that the refluxing of  $\text{H}_2\text{SO}_4$  took place at the base of the neck of the flask. This was continued about 5 minutes to dehydrate the silica thoroughly.

After digestion was over, the flask was removed from heater, cooled and a little quantity of water was added to it. Then the contents of flask was filtered through a pre weighed whatman No.42 filter paper. Thus the silica was accumulated over the filter paper which was then dried along with filter paper in the oven. The weight of filter paper along with silica was then recorded. The weight of filter paper was deducted from the total weight of filter paper and silica.



Chapter Opener Page

iv. Experimental  
results

## CHAPTER- IV

### EXPERIMENTAL RESULTS

Results of the field experiments on screening of sorghum varieties for resistance to the attack of shoot fly (Atherigona seccata Rond.) and stem borer (Chilo partellus Swin. ) are presented in this chapter.

#### A) Shoot fly (Atherigona seccata Rond.)

As stated earlier twentyone sorghum lines were tested in kharif and rabi seasons, 1978-79.

#### I. Kharif

##### a) Number of eggs laid

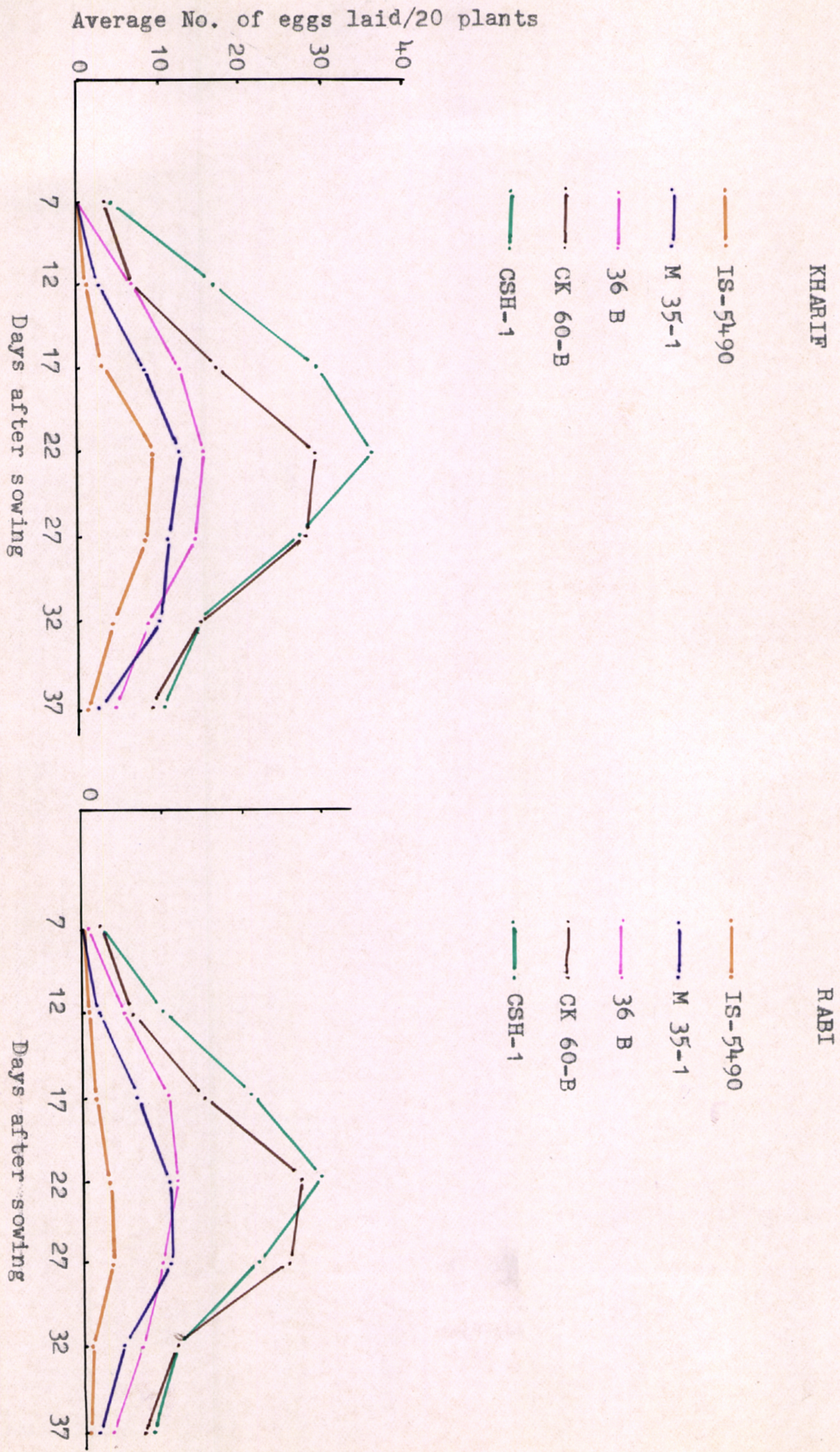
The data in respect of the average number of eggs laid on 20 plants of each variety recorded at five days interval starting from 7 days after sowing upto 37 days are given in Table-1.

It may be seen from the data that the egg laying was started 7 days after sowing which steadily increased and was maximum on 22nd day. The number of eggs laid then declined slowly.

The observations recorded 7 days after sowing showed that there was no egg laying on varieties IS-5490, M 35-1 and 36 B. The maximum oviposition was observed on CK 60-B (3-33/ 20 plants) which was significantly higher as compared to rest of the varieties except CSH-5 and 2077-B.

From the observations recorded 12 days after sowing,

Fig. 1 : Average number of eggs laid by A. soccata Rond. at different stages of growth on some sorghum entries during kharrif and rabi 1978-79.



it was revealed that the number of eggs laid on IS-5490 (1.33/20 plants) was significantly lowest compared to the rest of the varieties except M 35-1. The highest egg laying was observed on CSH-1 (16.33/20 plants) followed by 2077-B.

The data in respect of number of eggs laid at 17 days after sowing, indicated that the oviposition on IS-5490 (3.00/20 plants) was significantly low, as compared to other varieties. The maximum number of eggs was noticed on CSH-1 (29.33/20 plants) which was significantly high as compared to other varieties.

Observations recorded 22 days after sowing indicated that the egg laying on the plants of variety IS-5490 (9.33/20 plants) was significantly lower than the rest of the entries <sup>/except</sup> 168 and M 35-1. The maximum number of eggs were observed on CSH-1 (36.00/20 plants).

At 27th day after sowing, number of eggs observed on the variety IS-5490 (8.33/20 plants) was significantly lower than the rest of the varieties except 1324 and M 35-1, which were on par. The variety CK 60-B (28.00/20 plants) was preferred the most for oviposition followed by CSH-1.

The observations recorded 32 days after sowing revealed that the variety IS-5490 (4.33/20 plants) was the least preferred by shoot fly for eggs laying, while maximum number of egg laying was observed on variety CK 60-B (15.00/20 plants) and CSH-1 (15.00/20 plants) followed by CSH-5.

The observations recorded 37 days after sowing showed

that the variety IS-5490 (1.66/20 plants) had the lowest number of eggs which was significantly less than the other varieties except M 35-1 and GM-1-5 x IS-3922 (393). The maximum eggs were recorded on CSH-1 (10.66/20 plants) followed by CSH-5 and CK 60-B.

b) Dead hearts

The observations regarding the percentage of dead hearts caused due to attack of shoot fly recorded at five days interval starting from 7 days after sowing and continued upto 37 days are presented in Table-2.

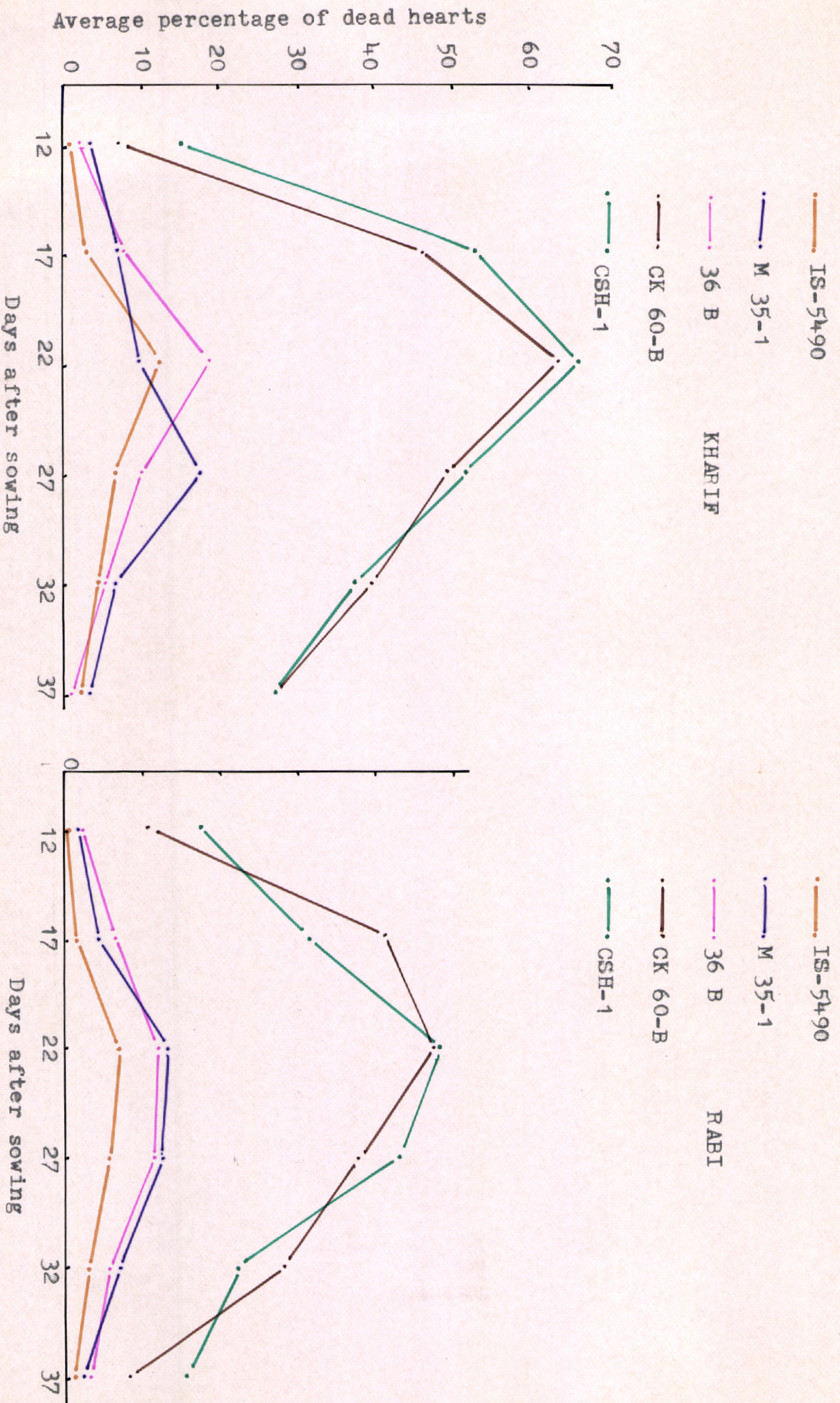
There were no dead hearts upto 7 days after sowing on any of the varieties.

The observations regarding damage caused by shoot fly at the 12th day after sowing indicated that the infestation on the variety IS-5490 (0.29%) was significantly less than the rest of the varieties. The maximum infestation was observed in CSH-1 (15.83 %) which was significantly higher than the rest of the entries except CSH-5.

The data recorded on dead hearts caused by the pest during the period between 13 to 17 days after sowing revealed that the incidence of shoot fly on the variety IS-5490 (2.95%) was significantly low as compared to the rest of the varieties. The maximum incidence was observed on CSH-1 (53.17%) which was significantly higher than all other entries.

The observations recorded on the dead hearts formed between 18 to 22 days after sowing showed that the incidence

Fig. 2 : Average percentage of dead hearts caused by A. soccata Rond. at different stages of growth on some sorghum entries during khariif and rabi 1978-79



of the pest on M 35-1 (9.57 %) was the lowest and was significantly less than the other entries. The maximum infestation was observed in CSH-1 (66.15%) which was significantly higher than the rest of the varieties.

The observations recorded on 27th day after sowing indicated that the infestation on the variety IS-5490 (6.45%) was significantly low. The maximum incidence was observed on CSH-1 (51.78%) which was significantly higher than all other entries except CK 60-B.

The incidence of the pest during the period between 28 to <sup>32</sup> days after sowing was the lowest on IS-5490 (4.55%) which was significantly less than the other entries except 36 B (5.66%). The maximum infestation was recorded on CK 60-B (39.88%) followed by CSH-1 and CS-35-1.

At the 37th day after sowing, lowest infestation was noticed on IS-5490 (2.24%) which was significantly less than the rest of the varieties except 36 B and M 35-1. The highest infestation was on CK 60-B (27.66%) followed by CSH-1 (27.64%).

The data about total percentage of dead hearts (Table-2) during the period of observation were significant. The variety IS-5490 (29.5%) showed the least incidence which proved to be significantly superior to all the varieties. The highest infestation was observed on CSH-1 (97.62%) which was significantly more than the rest of the entries.

Average percentage of dead hearts

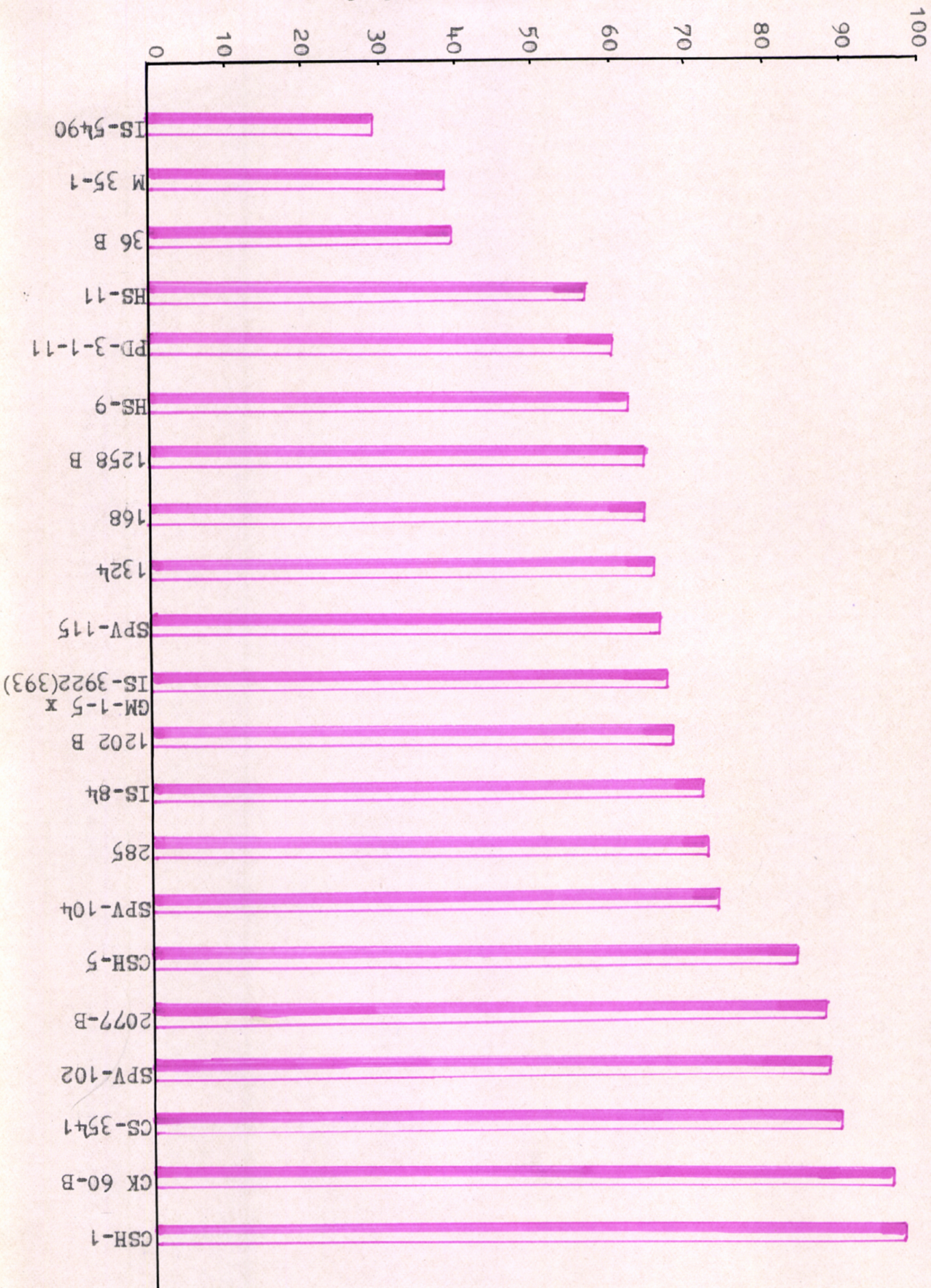


Fig. 3 : Average percentage of dead hearts caused by *A. soccata* Rond. to different sorghum entries (Kharif) 1978-79.

c) Number of eggs laid on tillers

The average number of eggs laid on 20 tillers recorded at five days interval starting from 22 days after sowing upto 37 days is presented in Table-3.

The observations recorded 22 days after sowing indicated that the egg laying was the lowest on IS-5490 (0.0/20 tillers) and was significantly less preferred for oviposition than the rest of varieties except M 35-1, SPV-102 and SPV-104. The maximum number of eggs was on the entry 2077-B (12.0/20 tillers) followed by CSH-5 (11.33/20 tillers).

The observations recorded at the 27th day after sowing showed that less number of eggs were deposited on the variety IS-5490 (0.33/20 tillers) which was significantly less than the rest of varieties except M 35-1 (1.0/20 tillers). The maximum egg laying was observed on CSH-1 (25.0/20 tillers).

At the 32nd day after sowing, the lowest number of eggs was observed on entry M 35-1 (0.66/20 tillers) and IS-5490 (0.66/20 tillers). The maximum number of eggs was on CSH-1 (9.33/20 tillers) which was significantly high as compared to the rest of the entries.

The observations recorded 37 days after sowing showed that the egg laying on IS-5490 was the least (0.0/20 tillers) and was significantly low than other varieties except M 35-1 (0.33/20 tillers). The maximum number of eggs <sup>was</sup> found on the variety 2077-B (22.66/20 tillers) followed by CSH-1 ( 22.00/20 tillers).

d) Dead hearts in tillers

The observations on the infestation of A. gossata on tillers were recorded at five days interval starting from 22 day after sowing and continued upto 37 days after sowing. These are presented in Table-4.

There was no dead heart formation in tillers of any of the varieties when observed at the 22nd day after sowing.

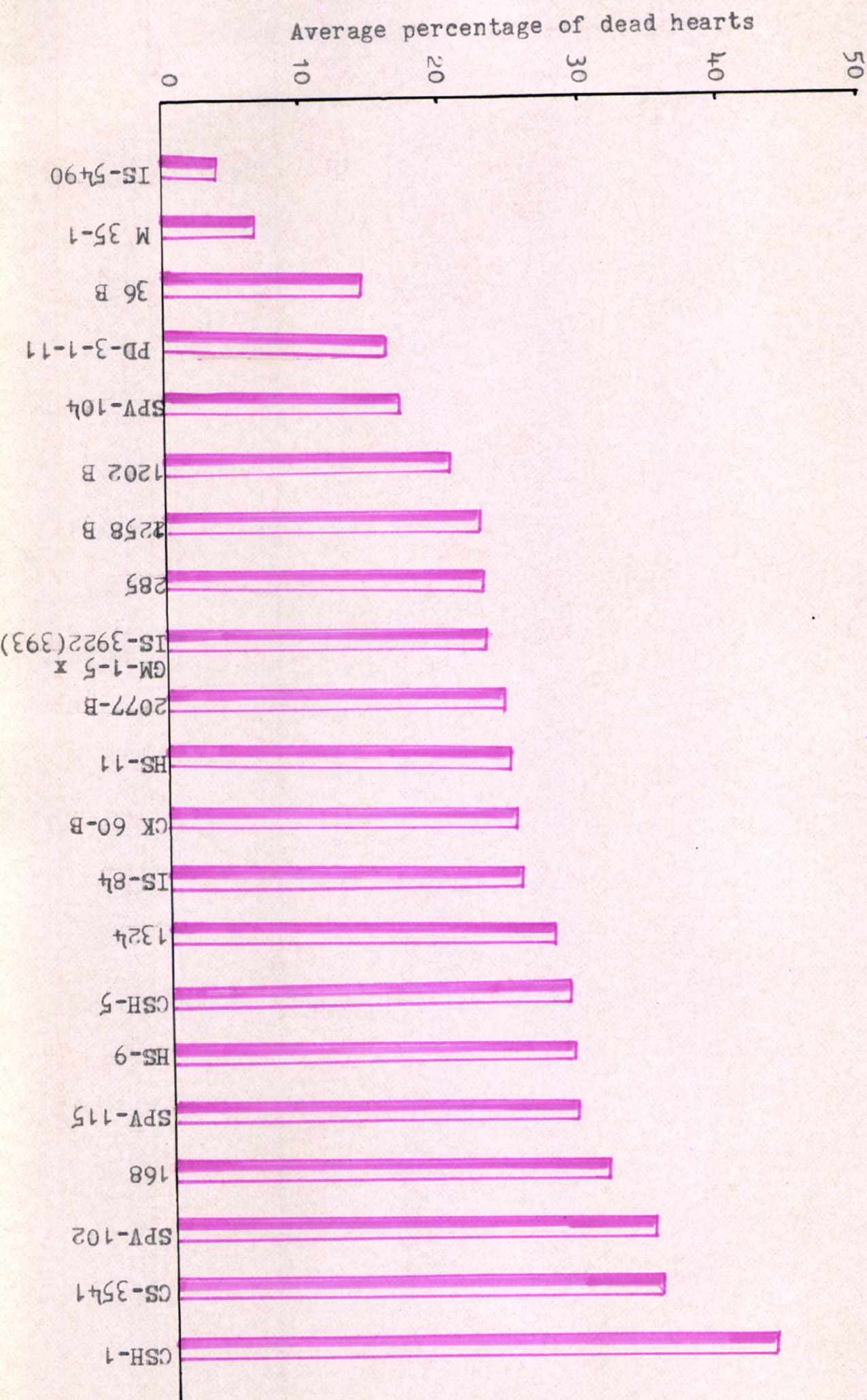
The observations recorded on dead hearts caused by the pest at the 27th day after sowing revealed that the incidence was the lowest on the variety IS-5490 (0.0%) and was significantly less than all other varieties. The maximum infestation was observed on CSH-1 (11.08%).

The dead hearts caused by shoot fly from 28 to 32 days after sowing showed that the incidence on the variety IS-5490 (1.68%) was significantly lower than the remaining varieties. The maximum infestation was recorded on CSH-1 (23.97%).

The incidence of A. gossata recorded during the period between 33 to 37 days after sowing revealed that the infestation on the variety M 35-1 (2.36%) was significantly less than the rest of the entries except IS-5490 (2.38%). The maximum infestation of shoot fly was observed on the variety CS-3541 (18.78%) followed by CSH-1 and SPV-102.

The data regarding the total percentage of dead hearts (Table-4) in tillers caused during the period of observations indicated that the pest incidence was the lowest on IS-5490 (4.03%) which was significantly lower than all other varieties. The maximum infested tillers were noticed in CSH-1(43.47%).

Fig. 5 : Average percentage of dead hearts caused by A. soccata Rond. to tillers in different entries of sorghum ( Khariif ) 1978-79.



## II. Rabi

### a) Number of eggs laid

The average number of eggs laid per 20 plants at five days interval starting from 7 days after sowing upto 37 days are presented in Table-5.

It can be seen from the data that the oviposition was low at the 7th day after sowing which slowly increased and reached at its peak at the 22nd day and gradually declined thereafter.

The observations recorded at 7th day after sowing showed that there was no egg laying on the entries IS-5490 and M 35-1. The highest number of eggs ( 3.0/20 plants) was recorded on CSH-5.

The observations recorded 12 days after sowing showed that the variety IS-5490 (1.0/20 plants) had significantly less number of eggs than rest of the varieties except M 35-1 (2.0/20 plants). The maximum number of eggs were observed on 2077-B (12.0/20 plants) which was significantly higher than the rest of the varieties except CSH-1, CSH-5, 285 and IS-84.

At the 17th day after sowing, the egg laying was the least on IS-5490 (2.0/20 plants). The maximum egg laying was observed on CSH-1 (21.0/20 plants) followed by 2077-B and CS-3541.

The average number of eggs elaid at the 22nd day after sowing was significantly low on the variety IS-5490(3.66/20 plants). The maximum number of eggs were observed on CSH-1

(29.33/20 plants) followed by CSH-5, CK 60-B and 2077-B.

The variety IS-5490 (4.0/20 plants) also showed less number of eggs at 27th day after sowing. The maximum number of egg laying was observed on the variety CK 60-B (25.33/20 plants).

The observations recorded 32 days after sowing revealed that the average number of eggs on the variety IS-5490 (1.0/20 plants) was significantly less than other entries. The maximum number of eggs was found on CSH-5 (18.33/20 plants) followed by PD-3-1-11, SPV-10<sup>4</sup>, CS-3541, CSH-1 and CK 60-B.

Observations recorded 37 days after sowing indicated that the lowest number of eggs was noticed on IS-5490 (0.33/20 plants) which was significantly less than the rest of entries except M 35-1 (2.0/20 plants). The maximum number of egg laying was observed on CSH-5 (10.0/20 plants) followed by CK 60-B CSH-1 and IS-84.

b) Dead hearts

The observations on the incidence of shoot fly were recorded at five days interval starting from 7 days after sowing upto 37 days. The data are presented in Table-6.

There were no dead hearts caused by A. gossypii at the observations recorded 7th day after sowing.

The dead hearts recorded at the 12th day after sowing indicated that the variety IS-5490 (0.00%) was significantly less susceptible to the attack of A. gossypii Rond. It was

however, observed to be on par with M 35-1 and 36 B. The maximum incidence was observed on CSH-1 (17.94%).

The observations recorded on dead hearts formed during the period from 13 to 17 days after sowing showed that the incidence of shoot fly on IS-5490 (1.32%) was significantly low as compared to all other varieties. The maximum incidence of 40.38 per cent was observed on the entry CK 60-B.

The incidence of the pest recorded on 22nd and 27th day after sowing showed that the variety IS-5490 proved to be significantly less susceptible than the rest of the varieties having the percentage of dead hearts upto 6.43 and 5.88 respectively. The maximum incidence was observed in the entry CSH-1, i.e. 47.78 and 42.37 per cent respectively.

At the 32nd day after sowing, the lowest infestation was noticed on IS-5490 (2.82 %) which was significantly less than the rest of entries except 36 B (5.52%). The maximum infestation was observed on variety CK 60-B (27.22%).

The data recorded on dead hearts caused by the pest during the period between 33 to 37 days after sowing revealed that the incidence of the pest on variety IS-5490 (1.45%) was significantly low as compared to the rest of the cultivars except M 35 -1 (2.34%). The maximum infestation was noticed on the variety CK 60-B (15.75%).

The observations on the total percentage of dead hearts (Table-6) caused by A. gossata Rond. throughout the period

Average percentage of dead hearts

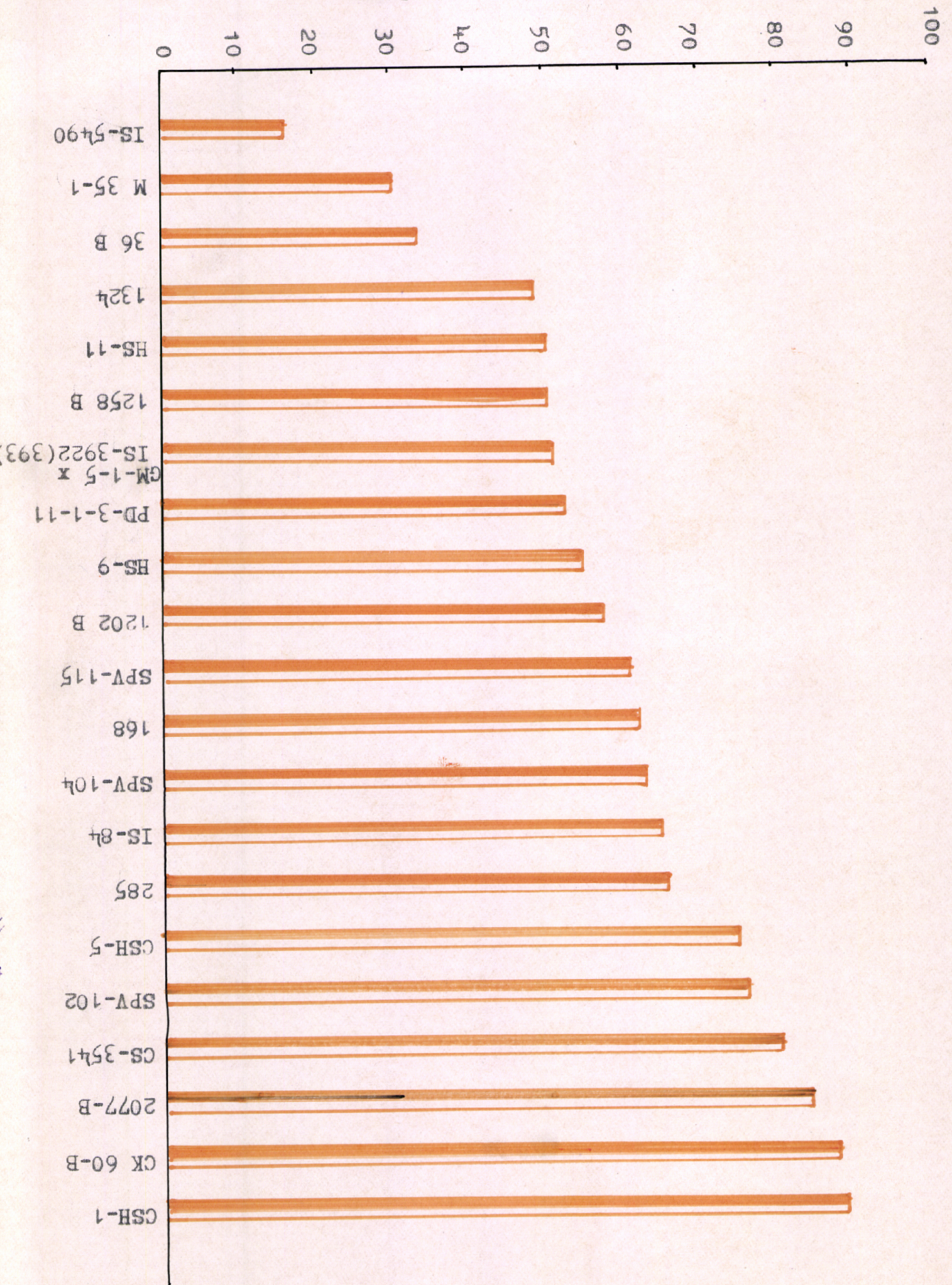


Fig. 4 : Average percentage of dead hearts caused by A.soccata Rond. to different sorghum entries ( Rabi ) 1978-79.

of infestation indicated that the variety IS-5490 (16.80%) was the least affected. The varieties, M 35-1 and 36 B were relatively less susceptible than other varieties and average percentage of dead hearts in these varieties was 30.11 and 33.58 respectively. The maximum incidence was observed on CSH-1 (88.58%) followed by CK 60-B (87.49 %).

c) Number of eggs laid on tillers

The observations recorded on the average number of eggs laid on 20 tillers of twentyone varieties at five days interval starting from 22 days after sowing upto 37 days are presented in Table 7.

The observations recorded at the 22nd day after sowing indicated that the lowest number of eggs was laid on the variety IS-5490 (0.0/20 tillers) which was significantly lower than other varieties except M 35-1, HB-9 and SPV-104. The variety 2077-B was preferred the most for oviposition (13.0/20 tillers).

At the 27th day after sowing, the variety IS-5490 (0.0/20 tillers) showed significantly less number of eggs as compared to other varieties except M 35-1 (0.66/20 tillers). The maximum egg laying on tillers was observed on CSH-1 (20.33/20 tillers) which was on par with 2077-B (18.66/20 tillers).

The observations recorded at the 32nd day after sowing indicated that the egg laying on the variety IS-5490 (0.66/20 tillers) was significantly less than the rest of the

varieties except M 35-1 (1.33/20 tillers). The maximum number of eggs were observed on variety CSH-1 (27.0/20 tillers) followed by 2077-B (24.0/20 tillers).

The data recorded at 37th day after sowing indicated the lowest number of eggs on the varieties M 35-1 (0.33/20 tillers) and IS-5490 (0.33-20 tillers) which was significantly lower than the rest of the varieties except 168. The variety 2077-B was preferred the most for oviposition (21.33/20 tillers) followed by CSH-5 and CSH-1.

a) Dead hearts in tillers

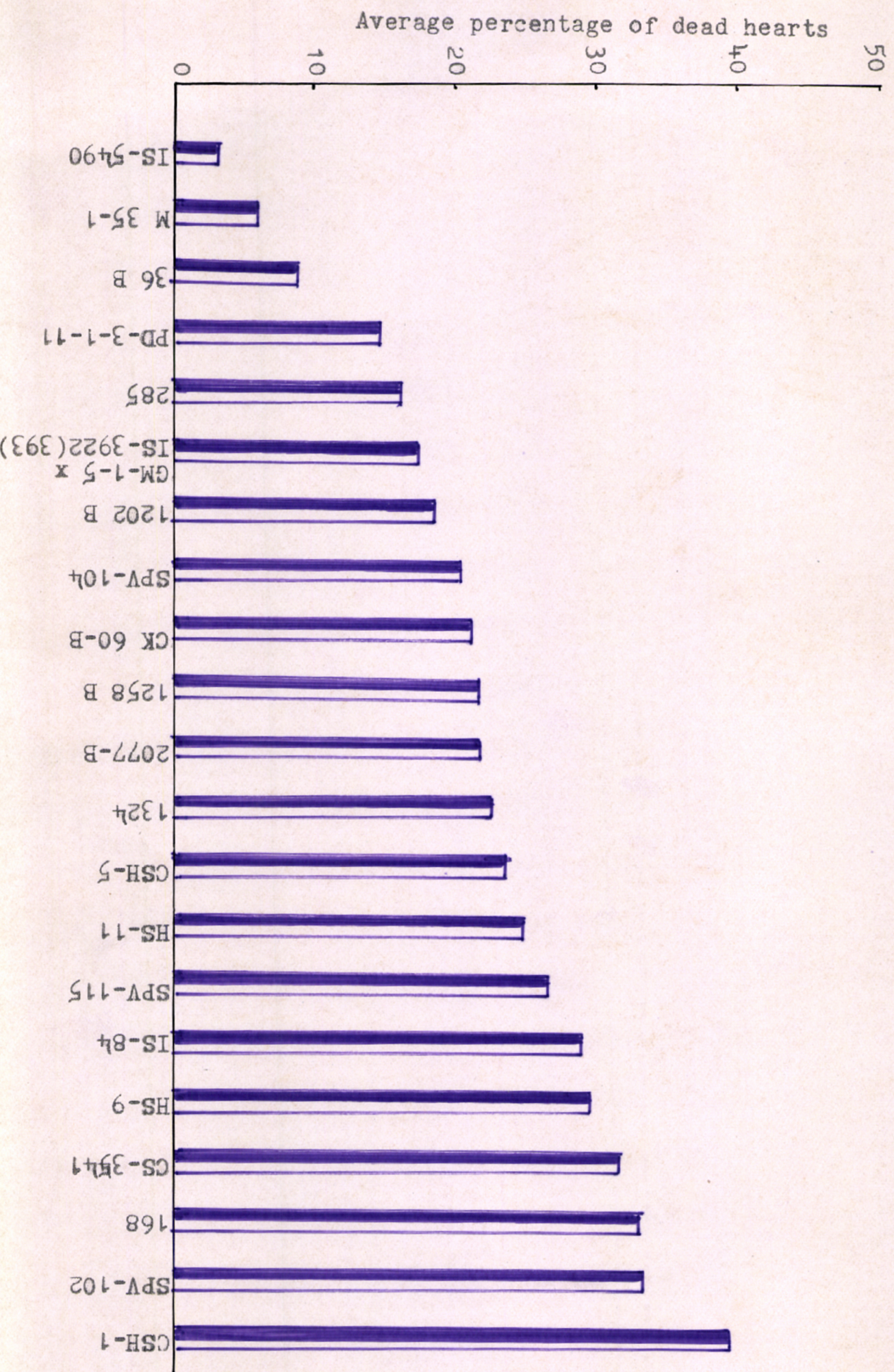
Observations recorded on the infested tillers at five days interval starting from 22 days after sowing upto 37 days are presented in Table-8.

There was no dead heart formation upto 22 days after sowing on tillers of any of the varieties tested.

The observations recorded on dead hearts of tillers caused by shoot fly from 23 to 27 days after sowing indicated that the infestation in the variety IS-5490 (0.00%) was significantly less than other varieties. The maximum infestation was observed in CSH-1 (13.34%).

The incidence of the pest recorded during the period between 28 to 32 days after sowing showed that the percentage of dead hearts on IS-5490 (0.94%) was significantly low as compared to other varieties. It was the highest in case of SPV-102 (18.43%). CSH-1 and 168 were however, on par with

Fig. 6 : Average percentage of dead hearts caused by A. soccata Rond. to tillers  
 different entries of sorghum (rabi ) 1978-79.



SPV-102.

The average percentage of dead hearts on tillers formed during the period from 33 to 37 days after sowing was significantly low on IS-5490 (2.67%) than the rest of entries except 36 B and M 35-1. The maximum incidence was observed on CSH-1 (13.95%) followed by SPV-115, 168 and SPV-102.

The total percentage of infestation on tillers (Table-8) was significantly low on the variety IS-5490 (3.57%). The maximum infestation was recorded on CSH-1 (39.16%) followed by SPV-102 and 168.

e) Pooled analysis

The results in respect of number of eggs laid on mother shoots, tillers and dead hearts caused by shoot fly in the two seasons ( Kharif and rabi ) were statistically analysed. The data are presented in Tables- 9-12.

It may be seen that the data were significant and the variety IS-5490 had significantly less number of eggs as compared to all other varieties. At the 7th day, there was less number of eggs on this variety, while M 35-1 was found to be the next best.

At the 12th day observation, the number of eggs laid on IS-5490 (1.16) were significantly low as compared to rest of the varieties except M 35-1 (2.16). CSH-1 had significantly maximum number of eggs (13.16). The entries 2077-B, CSH-5, 285, IS-84 were however on par with CSH-1.

Like the previous observations, the number of eggs laid on IS-5490 at 17, 22, 27, 32 and 37th day were significantly low. The next promising variety was M 35-1. The variety CSH-1 consistently showed highest number of eggs at all the observations except that recorded on 27th day where-in CK 60-B showed the maximum eggs.

The data in respect of dead hearts was observed to be significantly at all the observations. The variety IS-5490 had significantly less percentage of dead hearts consistently at all the observations. The variety M 35-1 and 36 B were found to be the next best and were on par with each other. The maximum percentage of dead hearts was observed in CSH-1 throughout the period. The entries like CK 60-B, 2077-B, CS-35-1, SPV-102, were also observed to be equally susceptible.

## II. Stem borer ( C. partellus S. )

The observations regarding average number of larvae, pupae, tunnels per 5 plants and percentage stem length tunnelled, percentage internodes attacked recorded in kharif season are presented in Table-13.

The data on the average number of larvae showed that there was a significant variation among the varieties. The variety HS-9 (1.66) showed the highest number of larvae which was significantly more than the other varieties except CK 60-B. The varieties like IS-5490 (0.0) and 285 (0.0) showed the lowest average number of larvae which was significantly less than rest of the entries except 1324, M 35-1,

1202 B, CS-3541, SPV-102, 1258 B, SPV-104.

The observations recorded on average number of pupae indicated that there was a significant differences among the varieties. The average number of pupae was less in the variety IS-5490, 36 B and PD-3-1-11. It was significantly lower than the remaining varieties except CS-3541, 2077-B, 168, SPV-104, HB-7, 1324, 1258 B, 1202 B. Maximum number of pupae was observed in the variety SPV-102 (1.20) followed by CSH-5 and GM-1-5 x IS-3922(393).

The observations showed that the lowest number of tunnels were caused in the variety M 35-1 (0.6/5 plants) which was significantly less than the rest of varieties except PD-3-1-11, IS-5490 and IS-84, while the maximum tunnels were recorded in the variety CK 60-B (4.9/ 5plants) followed by CSH-5.

The observations recorded on percentage stem length tunnelled showed that it was significantly lower in the variety IS-5490 (3.47%) than rest of the varieties. The highest percentage of stem length tunnelled was observed in CSH-1 (18.67%).

The observations regarding the percentage of internodes attacked by C. partellus in different varieties were significant. The minimum percentage of internodes infested by the pest was observed in the variety M 35-1 (4.42%) which was significantly lower than the remaining varieties except 1202 B, IS-5490 and 1258 B. The highest percentage of

internodes attacked was observed in CSH-1 (19.17%).

Similar observations recorded at the time of harvest in rabi season are given in Table-14.

The variety CK 60-B and SPV-102 showed maximum number of larvae, which was significantly higher than rest of the varieties except HS-11, CSH-1, IS-84 and 168. The lowest number of larvae was observed in the variety IS-5490.

The observations on average number of pupae indicated that CSH-5 showed significantly more number of pupae than the remaining varieties. The data regarding average number of tunnels caused by stem borer indicated that it was significantly less in IS-5490 (0.4 / 5 plants) as compared to other varieties except CS-3541, PD-3-1-11, and M 35-1. The maximum tunnels were recorded in SPV-102 (3.8/ 5 plants) followed by CK 60-B, 285, IS-84, 2077-B and CSH-1.

The observations on the percentage of stem length tunnelled by C. partellus showed the highest percentage in CSH-1 (12.00%) which was significantly more than the rest of the varieties. The lowest stem <sup>tunnelling</sup> was observed in the variety IS-5490 (0.99%).

The response of different varieties to the percentage of internode infestation was significant. The intensity of percentage of infested internodes was significantly low in the variety IS-5490 (2.25%) than the rest of varieties. The maximum percentage of internode infested by the pest was recorded in CSH-1 (15.34%) followed by 2077-B.

### **III. Plant growth observations**

#### **a) Leaf breadth (Kharif)**

The fourth leaf was selected to record the observations. The data regarding breadth of leaves measured on five randomly selected plants from 17 days after sowing and continued at 5 days interval upto 37 days are presented in Table-15.

The maximum leaf breadth was noticed in CSH-1 (1.20 cm) at 17 days after sowing which was significantly more than the rest of varieties except CSH-5, CS-3541 and CK 60-B. Leaf breadth was minimum in variety IS-5490 (0.85 cm).

Observations recorded 22 days after sowing showed highest leaf breadth in CSH-1 (1.25 cm). It was significantly more than remaining varieties except 2077-B and CK 60-B. The lowest was observed in variety IS-5490 (0.94 cm). The observations recorded 27 days after sowing revealed that there was significantly minimum leaf breadth in variety IS-5490 (1.04 cm) than the other varieties except M 35-1 and 36 B, while it was maximum in CSH-1 (1.32 cm). CK 60-B was however, on par with CSH-1.

At the 32nd day after sowing, the minimum leaf breadth was observed in the variety IS-5490 (1.10 cm) which was significantly less than the rest of varieties except M 35-1 and 36 B. The maximum leaf breadth was noticed in CSH-1 (1.40 cm) which was significantly more than the other varieties except CK 60-B.

The observations recorded 37 days after sowing showed

that the variety IS-5490 (1.14 cm) had the minimum leaf breadth which was significantly less than the remaining varieties. It was maximum in CSH-1 (1.48 cm).

Similar observations recorded in Rabi season are given in Table 16.

The observations recorded 17 days after sowing showed that leaf breadth was the lowest in the variety IS-5490 (0.83 cm) which was significantly less than other varieties, while it was more in CSH-1 (1.13 cm) followed by SPV-102, CS-3541, 2077-B and CK 60-B.

Observations recorded 22 days after sowing indicated that the leaf breadth was maximum in CSH-1 (1.17 cm) which was significantly more than other varieties except CSH-5, CS-3541, 2077-B and CK 60-B. Minimum leaf breadth was noticed in the variety IS-5490 (0.90 cm).

At the 27th day after sowing, leaf breadth was significantly less in the variety IS-5490 (0.99 cm). Maximum leaf breadth was observed in CSH-1 (1.24 cm).

The entry IS-5490 (1.05 cm) had also the least leaf breadth at the 32nd day after sowing which was significantly less than the rest of the varieties. The highest leaf breadth was observed in CSH-1 (1.31 cm) and was significantly more than in the remaining varieties except CK 60-B.

Observations recorded 37 days after sowing showed that the leaf breadth was minimum in IS-5490 (1.09 cm) and was significantly less than the rest of varieties except M 35-1, while it was maximum in CSH-1 (1.42 cm).

**b) Number of leaves**

The observations regarding number of leaves were recorded only in rabi season, at six days interval starting from 12 days after sowing and continued upto 36 days. The data are presented in Table-17.

It was observed that the average number of leaves per plant was maximum on the variety IS-5490 (4.9) on 12th day after sowing and was significantly more than other varieties except M 35-1 (4.8). The least numbers of leaves were recorded on CSH-1 (3.3) which was significantly less than the rest of varieties.

The observations recorded 18 days after sowing showed that IS-5490 (5.5) had significantly more number of leaves than the remaining varieties except M 35-1 (5.4). The minimum number of leaves were observed on CSH-1 (4.2) followed by CK 60-B (4.3).

Observations recorded 24 days after sowing indicated the lowest average number of leaves on CSH-1 (5.9) which was significantly less than other varieties except CK 60-B (6.1). The highest number of leaves were noticed on IS-5490 (7.5) and was significantly more than the rest of the varieties except M 35-1 (7.3).

At the 30th day after sowing maximum number of leaves were observed on variety IS-5490 (9.1) which was significantly more than the rest of the varieties except M 35-1 (9.0). The minimum number of leaves were recorded on CSH-1 (6.9) followed by CK 60-B (7.1).

The data recorded at the 36th day after sowing indicated significantly highest average number of leaves on IS-5490 (10.2). M 35-1 (9.9) however, was observed to be on par with it. CSH-1 (7.3) had significantly less number of leaves than the remaining varieties except CK 60-B and 2077-B.

#### IV. Silica determination of plant samples

In present investigation, eighteen sorghum entries were selected for determination of silica in the stems and leaf sheaths. The observations were converted into percentage of  $\text{SiO}_2$  on dry matter basis. The data were statistically analysed and the data are presented in Table-18.

The data regarding the estimation of  $\text{SiO}_2$  in 4th leaf stage showed the maximum percentage of  $\text{SiO}_2$  in the variety IS-5490 (28.05 per cent) followed by M 35-1, 36 B and NS-9. The minimum percentage of  $\text{SiO}_2$  was observed in 2077-B (6.30 per cent) followed by 168, SPV-102, CK 60-B and CSH-5.

The observations recorded on percentage of  $\text{SiO}_2$  in 6th leaf stage indicated that the variety IS-5490 (19.97 per cent) had the highest percentage of  $\text{SiO}_2$  followed by M 35-1, 1258 B, 36 B and 285. The minimum percentage of silica was observed in the variety CK 60-B (11.97 per cent) followed by 168, 2077-B, SPV-102 and CSH-1. Results of the experiments indicated that the  $\text{SiO}_2$  content in the plant (stem and leaf sheaths) were increased from 4th leaf stage to the 6th leaf stage.

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v. Discussion

## CHAPTER- V

### D I S C U S S I O N

The results of the field experiments conducted to test the varietal reaction of twentyone entries of sorghum to the attack of shoot fly (Atherigona soccata Fond.) and stem borer (Chilo partellus Swin.) are presented in the earlier chapter. These are briefly discussed in the following pages.

The twentyone varieties screened were sown late in kharif and rabi seasons than the recommended dates, so that these are subjected to the maximum infestation of shoot fly.

#### I. Shoot fly

##### Preference for oviposition

The number of eggs laid on the mother shoots as well as on tillers were recorded in both the seasons. It was observed that, there is a definite difference in ovipositional preferences among the varieties. The minimum number of eggs were observed on tolerant lines IS-5490, M 35-1 and 36 B. The maximum number of eggs were noticed on CSH-1, CSH-5, CK 60-B, 2077-B, CS-3541, IS-84 and SPV-102. This trend of egg laying was consistently observed in both the seasons and on both mother shoots and tillers. On the basis of the dead hearts, the entries IS-5490, M 35-1 and 36 B can be grouped as tolerant varieties. The results of the egg laying indicated that non-preference for oviposition may be one of the characters for varietal resistance to shoot fly. Similar observations were recorded by Jotwani et al. (1971 and 1971 a), Jain and

Bhatnagar (1962), Shivpuje *et al.* (1976) and Blum (1967). The varietal screening carried out in All India Coordinated Sorghum Improvement Project, also show similar results (Anonymous, 1972-73, 1974-75). These observations, however differ from Ponnaiya (1951) who reported that equal number of eggs were laid on resistant as well as susceptible varieties.

It was further observed that number of eggs laid was less during the first two weeks after sowing which reached the peak in the third week and then declined slowly. In case of tillers the maximum infestation was recorded a months after sowing, It is felt that this is obvious since by this time survived mother shoots had grown up and the tillers had just come up and flies had naturally preferred these for egg laying.

#### Dead hearts

From the results obtained in both the seasons, it was observed that the varieties IS-5490, M 35-1 and 36 B showed the least infestation while the entries CSH-1, CK 60-B, CS-3541, 2077-B and CSH-5 were found to be heavily infested. Even in the case infestation on tillers, the varieties IS-5490, M 35 -1 had the minimum infestation. This shows that the varieties showed their comparative tolerance irrespective of the seasons, main shoots or tillers.

In general, the infestation reached the maximum during third and fourth week in both the seasons. Similar observations were reported by Krishnananda *et al.* (1970), Narayana (1975) and Dalvi (1975). From these observations it can be

stated that the varieties which grow fast in the initial stage will escape the attack of the pest.

During the present investigation the varieties IS-5490, M 35-1 and 36 B were found to be comparatively resistant to shoot fly. These observations confirm the findings of Taley *et al.* (1978), Sadakathulla *et al.* (1978) and others (Anonymous, 1976-77) in respect of the variety IS-5490. The tolerance of the variety M 35-1 to attack of shoot fly has been reported by several workers (Blum, 1965; Parameswarappa *et al.*, 1968; Dalvi, 1975; Jadhav, 1977; Bapat *et al.*, 1977). The entries like CSH-1, CK 60-B, CS-3541, 2077-B and CSH-5 which were found to be susceptible during present investigation behaved in the similar way in the earlier tests carried out by Sharma (1968), Krishnananda *et al.* (1970), Jetwani *et al.* (1971), Dalvi (1975), Narayana (1975), Shivpuje *et al.* (1976).

Besides, the character of ovipositional preference for resistance or otherwise, certain morphological and physiological characters have been also reported to associate with the differential reaction of a variety to the attack of the shoot fly. The leaf width appears to be one of the factors to varied reaction. Since the 3rd and 4th leaves are usually preferred for egg laying ( Krishnananda *et al.*, 1970), the width of 4th leaf was recorded at five days interval starting from 17 days after sowing. It was observed that the variety IS-5490, M 35-1 and 36 B had the minimum leaf breadth, while the susceptible entries like CSH-1, CK 60-B, 2077-B, showed

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comparatively more width. Since these varieties had shown more number of eggs, it is felt, that the varieties with broader leaves <sup>are</sup> preferred for egg laying.

The character of faster growth of main shoots and tillers has been also reported to be associated with the shoot fly resistance or otherwise. Blum (1967) reported that the faster growth rate of tillers escape the attack of shoot fly. The observations recorded during present investigations on average number of leaves from 12th days onwards also showed that more the number of leaves put on quickly by a variety, less it succumb to the attack of shoot fly. Similar observations were also made by Jain and Bhatnagar (1962), Blum (1969), Raghunath et al. (1972) and Narayana (1975), Jain and Bhatnagar (1962) also stated that there is positive correlation between number of eggs laid, leaf numbers and percentage infestation.

The data of the two seasons were pooled and it was statistically significant in respect of number of eggs laid and dead heart percentage. It can therefore <sup>be</sup> stated that the varieties IS-5490, M 35-1 and 36 B have showed consistent tolerance irrespective of season. Likewise the entries CSH-1, 2077-B, CK 60-B, CS-3541, SPV-102 showed susceptibility in both the seasons.

The colour of leaves and glossiness appeared to be one of the morphological characters responsible for varied reaction of a sorghum variety to the attack of shoot fly. The varieties IS-5490, M 35-1 and 36 B which are found to be

comparatively tolerant during present investigation have pale green colour while the susceptible entries like CSH-1, CK 60-B, 2077-B and CE-3541 have distinct dark green coloured leaves. It was observed that these susceptible varieties preferred for egg laying as indicated by the data on number of eggs laid. Similar observations were also reported by Blum (1967), Bapat *et al.* (1975), Vedamoorthy (1967) and Jotwani (1978).

Among the physiological characters, the content of the silica in the plants has been reported to be correlated to the infestation of borers. Djamin and Pathak (1967) on the basis of silica determination of rice plant stem, concluded that there is highly significant negative correlation between silica content and susceptibility to stem borer. Pennaiya (1951) also observed the same trend in case of jevar and reported that formation of silica units in the fourth leaf sheaths of seedling appeared to be a factor responsible for resistance in a variety to the attack of shoot fly. Dalvi (1975) also noticed significant negative correlation between percentage of  $\text{SiO}_2$  content and shoot fly infestation. The results of the estimation of silica content at 4th and 6th leaf sheaths and stem carried out during present investigation also indicated that comparative tolerant varieties like IS-5490, N 35-1 contain more quantity of  $\text{SiO}_2$  while the susceptible entries showed much less quantity.

## II. Stem borer

The stem borer, another important internal feeder of sorghum causes dead hearts, when it attacks the crop in seedling

stage. Such infestation in early stage of crop is not much in the Western Maharashtra region. However, the infestation is very common in the later stage of growth which continues even upto earhead formation. Presence of stem borer larvae in the stalk of the earhead is also not uncommon. The observations were therefore, recorded on the infestation of stem borer on the varieties tested during the present investigation. The data regarding the average number of larvae, pupae and tunnels observed were significant in both the seasons. The average number of larvae in M 35-1, IS-5490, 285, the pupae in IS-5490, 36 B, M-35-1 and PD-3-1-11 and tunnels in IS-5490, M 35-1, PD-3-1-11 were found to be minimum and maximum in entries like CSH-1, CK 60-B and SPV-102.

The variety IS-5490 showed the least percentage of stem tunnelled while CSH-1 was observed to be more susceptible. During khari, the lowest damage was observed in variety M35-1 and in rabi IS-5490 proved to be promising. CSH-1 was observed to be susceptible in both the seasons. The susceptibility of CSH-1 has also reported by other workers ( Jotwani et al., 1973; Dalvi, 1975).

From the present studies, it appears that there are definite lines in sorghum which are comparatively tolerant to shoot fly. Similarly the morphological characters like leaf breadth, colour of leaves and number of leaves also showed the definite correlation with the shoot fly damage. It is felt that, the lines proved promising could be used in future breeding programme taking into account the morphological character desirable for shoot fly tolerance.

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vi. Summary

## CHAPTER- VI

### S U M M A R Y

Sorghum is an important food crop of Maharashtra and is cultivated in both kharif and rabi seasons. It's cultivation in summer is also very common wherever there are irrigation facilities. Although, the efforts to boost of production of the crop have been successful to some extent, it has not been possible to cover major area under high yielding hybrid varieties because of their high susceptibility to insect pests. Among the various pests, the shoot fly is the major one which has in fact gained important pest status with the introduction of high yielding hybrid varieties.

Several chemicals have been tried for the control of the pest and some of them have been also recommended. These insecticides are not used on large scale because of the several problems associated with their use. The most important problem is the cost involved in their use and in marginal profit crop like jowar, their use becomes prohibitive.

Use of alternate methods to combat the pest problem have been inevitable. Among the other control measures, growing resistant varieties is the most cheapest and easy method which can be adopted by all the farmers.

Efforts are therefore, already initialed to find out varieties which would escape or resist the shoot fly attack. Some of the lines have been also reported to be promising. Since the new lines and hybrids are continuously developed, it was fact necessary to screen some of the promising entries

or for their resistance to shoot fly.

Twentyone varieties/hybrids of sorghum were obtained from All India Coordinated Sorghum Improvement Project, Rahuri and were screened under field conditions both in kharif and rabi seasons. Observations were recorded on the incidence of shoot fly and stem borer.

### I. Shoot fly

Observations were recorded on the preference for oviposition at 5 days interval starting from 7 days after sowing and continued upto 37 days. The egg laying started from 7 days on the mother shoots which steadily increased and was maximum at the 22nd day after sowing in both the seasons. Maximum number of eggs were observed on hybrid CSH-1 (36.0/20 plants) and CK 60-B (29.66/20 plants) in kharif season. In rabi, the maximum eggs were recorded on CSH-1 (29.33/20 plants) and 2077-B (27.66/20 plants). The varieties IS-5490, N 35-1 and 36 B had the least number of eggs in both the seasons. The observations recorded on number of eggs laid on tillers in both kharif and rabi seasons showed the same trend. The minimum number of eggs were noticed on variety IS-5490 and maximum on CSH-1.

Observations were recorded on dead hearts caused by shoot fly at five days interval starting from 7 days after sowing and continued upto 37 days. In kharif, the minimum total percentage of dead hearts was recorded on the variety IS-5490 (29.5%) which was significantly less than the rest

of the entries. The maximum percentage of dead hearts was noticed on CSH-1 (97.62%) followed by CK 60-B (95.77%). During rabi, the minimum total percentage of dead hearts was observed on the entry IS-5490 (16.80%) which was significantly lower than other varieties. The highest percentage of shoot fly damage was observed on CSH-1 (88.58%) followed by CK 60-B.

Similar observations were recorded in respect of dead hearts in tillers at 5 days interval starting from 22 days after sowing and continued upto 37 days. In both the seasons, the minimum percentage of dead hearts was recorded on IS-5490 which was significantly less than other varieties except M 35-1. Highest percentage of dead hearts was observed in CSH-1.

In order to find out the relationship of morphological characters with the incidence of shoot fly, leaf breadth was measured in both the seasons. The fourth leaf was selected for these observations since the 3rd and 4th leaves are usually preferred for egg laying. It was observed that the tolerant varieties viz., IS-5490, M 35 -1 had narrower leaves than those susceptible ones. Observations were also recorded on number of leaves put on by the plants at six days interval to find out whether faster growing varieties resistant the pest attack. The results indicated that the varieties proved to be tolerant had a faster growth rate as compared to susceptible ones. The entries with pale green leaves were

observed to be less preferred for egg laying.

In order to find out possible physiological characters for varied reaction to shoot fly, silica content were estimated in 4th and 6th leaf stage. The variety IS-5490 showed comparatively more silica content while 2077-B and CK 60-B showed the minimum.

## II. Stem borer

The data regarding the average number of larvae, pupae, stem length tunnelled and number of internode infested were collected at harvest. Average number of larvae, pupae and percentage stem length tunnelled were maximum in case of varieties like CK 60-B, CSH-1 and CK 60-B respectively. The percentage of internodes attacked by the pest was maximum in CSH-1 in both the seasons. The variety IS-5490 showed the minimum damage by the stem borer.

It is felt that the results of the present studies will be useful for future programme of breeding varieties resistant to shoot fly. However, the data collected are only for two seasons and need further confirmation.

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\* Original not seen



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# Appendix

Table 3 : Average number of eggs laid by *A. sescata* Rond. on tillers of different entries of sorghum during kharif 1978-79.

Sr. No.	Entry	Days after sowing	Number of eggs laid/20 tillers (Average of three replications)			
			22	27	32	37
1.	IS-5490		0.00	0.33	0.66	0.00
2.	M 35-1		0.33	1.00	0.66	0.33
3.	36 B		7.33	10.33	13.16	9.00
4.	PD-3-1-11		2.00	3.66	12.66	9.66
5.	SPV-104		1.33	8.00	7.66	7.00
6.	1202 B		5.33	12.33	17.66	14.33
7.	1258 B		6.00	14.00	18.00	15.10
8.	285		9.66	13.33	15.66	16.66
9.	GM-1-5 x IS-3922(393)		7.00	12.66	14.00	12.66
10.	2077-B		12.00	21.00	24.33	22.66
11.	HB-11		4.33	12.33	18.33	11.00
12.	CK 60-B		9.00	15.66	22.33	19.66
13.	IS-84		7.33	17.33	20.33	18.33
14.	1324		5.00	9.00	12.33	8.66
15.	CSH-5		11.33	19.33	24.00	19.00
16.	HB-9		2.00	10.00	17.00	12.33
17.	SPV-115		3.66	11.33	15.00	12.66
18.	168		5.33	9.66	13.00	14.00
19.	SPV-102		1.00	10.33	12.00	9.66
20.	CS-3541		8.66	19.33	20.66	18.00
21.	CSH-1		10.00	25.00	29.33	22.00
	S.E. ±		0.695	0.922	0.921	0.957
	C.D. at 5%		1.986	2.635	2.632	2.735

**Table 7 : Average number of eggs laid by *A. sorghana* Rond. on tillers of different entries of sorghum during rabi 1978-79.**

Sr. No.	Entry	Days after sowing	Number of eggs laid/20 tillers (Average of three replications)			
			22	27	32	37
1.	IS-5490		0.00	0.00	0.66	0.33
2.	M 35-1		0.33	0.66	1.33	0.33
3.	36 B		5.00	6.00	9.66	7.66
4.	PD-3-1-11		3.00	5.33	10.00	7.33
5.	285		6.66	10.00	13.66	9.66
6.	GM-1-5 x IS-3922(393)		5.00	8.33	13.33	10.66
7.	1202 B		4.00	10.00	13.00	11.33
8.	SPV-104		1.66	9.00	10.33	9.66
9.	CK 60-B		7.00	13.33	20.66	17.66
10.	1258 B		5.33	12.66	16.00	9.66
11.	2077-B		13.00	18.66	24.00	21.33
12.	1324		4.33	5.66	8.66	8.33
13.	CSH-5		9.33	17.00	22.66	19.66
14.	HS-11		3.66	9.00	13.66	11.33
15.	SPV-115		3.33	8.66	12.00	9.33
16.	IS-84		7.66	14.66	18.33	15.66
17.	HS-9		1.33	6.33	11.66	8.66
18.	CS-3541		9.00	16.00	17.00	16.66
19.	168		3.66	7.00	11.66	3.33
20.	SPV-102		2.00	7.33	10.66	8.66
21.	CSH-1		10.33	20.33	27.00	21.00
	S.E. $\pm$		0.678	1.201	2.165	0.994
	C.D. at 5%		1.936	3.422	6.018	2.840

**Table 11 : Pooled analysis of average number of eggs laid by shoot fly on different entries of sorghum tillers in kharif and rabi season 1978-79.**

Sr. No.	Entry	Days after sowing	Average number of eggs laid/20 tillers			
			22	27	32	37
1.	IB-5490		0.00	0.16	0.49	0.16
2.	M 35-1		0.33	0.83	0.99	0.49
3.	36 B		6.16	8.16	11.16	8.33
4.	PD-3-1411		4.00	6.99	11.33	8.49
5.	SPV-104		1.49	8.50	6.99	8.33
6.	1202 B		4.66	11.16	15.33	12.83
7.	GM-1-5 x IS-3922(393)		6.00	10.49	13.66	11.66
8.	1258 B		5.66	13.33	17.00	12.33
9.	285		8.16	11.66	14.66	10.66
10.	2077-B		12.50	19.83	24.16	21.83
11.	CK 60-B		8.00	14.49	21.49	18.66
12.	HS-11		3.99	10.66	15.99	11.16
13.	1324		4.66	7.33	10.49	8.49
14.	CSH-5		10.33	18.16	23.33	19.33
15.	IS-84		7.49	15.99	19.33	15.99
16.	SPV-115		3.49	8.83	13.50	10.99
17.	HS-9		1.66	8.16	14.33	10.49
18.	168		4.49	8.33	12.33	11.66
19.	CS-3541		8.83	17.66	18.83	17.33
20.	SPV-102		1.50	8.83	11.33	9.16
21.	CSH-1		10.16	22.66	28.16	22.16
	S.E. $\pm$		1.87	1.21	1.87	1.14
	C.D. at 5%		5.23	3.38	5.23	3.19

**Table 15 : Average breadth of 4th leaf of different entries of sorghum recorded in kharif season 1978-79.**

Sr. No.	Entry	Days after sowing	Average of three replications				
			17	22	27	32	37
1.	IS-5490		0.85	0.94	1.04	1.10	1.14
2.	M 35-1		0.98	1.04	1.08	1.15	1.20
3.	36 B		1.02	1.06	1.10	1.66	1.22
4.	1324		1.04	1.09	1.12	1.18	1.26
5.	HS-11		1.01	1.08	1.11	1.20	1.25
6.	1258 B		1.08	1.12	1.14	1.20	1.28
7.	GN-1-5 x IS-3922(393)		1.07	1.14	1.17	1.24	1.30
8.	PD-3-1-11		1.08	1.13	1.17	1.23	1.31
9.	BS-9		1.09	1.12	1.16	1.21	1.25
10.	1202 B		1.06	1.11	1.15	1.24	1.29
11.	SPV-115		1.10	1.13	1.19	1.25	1.32
12.	168		1.07	1.13	1.20	1.25	1.31
13.	SPV-104		1.06	1.10	1.21	1.27	1.34
14.	IS-84		1.09	1.12	1.22	1.26	1.35
15.	285		1.08	1.13	1.18	1.26	1.36
16.	CSB-5		1.12	1.17	1.21	1.29	1.35
17.	SPV-102		1.10	1.17	1.24	1.33	1.39
18.	CS-3541		1.12	1.18	1.23	1.31	1.37
19.	2077-B		1.14	1.20	1.25	1.32	1.37
20.	CK 60-B		1.15	1.21	1.28	1.36	1.42
21.	CSH-1		2.20	1.25	1.32	1.40	1.48
	S.E. $\pm$		0.021	0.020	0.022	0.020	0.018
	C.D. at 5%		0.060	0.057	0.062	0.057	0.051

**Table 16 : Average breadth of 4th leaf of different entries of a sorghum recorded in rabi season 1978-79.**

Sr. No.	Entry	Days after sowing	Average of three replications				
			17	22	27	32	37
1.	IS-5490		0.83	0.90	0.99	1.05	1.09
2.	M 35-1		0.96	1.00	1.06	1.09	1.14
3.	36 B		1.01	1.04	1.08	1.11	1.18
4.	1324		1.03	1.07	1.10	1.16	1.22
5.	BS-11		1.03	1.06	1.10	1.15	1.20
6.	1258 B		1.04	1.09	1.11	1.15	1.22
7.	GM-1-5 x IS-3922(393)		1.07	1.08	1.10	1.14	1.19
8.	PD-3-1-11		0.99	1.04	1.12	1.17	1.23
9.	BS-9		1.06	1.09	1.11	1.17	1.25
10.	1202 B		1.05	1.09	1.12	1.17	1.23
11.	SPV-115		1.05	1.09	1.13	1.18	1.25
12.	168		1.05	1.08	1.13	1.18	1.24
13.	SPV-104		1.06	1.10	1.14	1.19	1.26
14.	IS-84		1.04	1.08	1.13	1.19	1.27
15.	285		1.06	1.10	1.14	1.20	1.29
16.	CSH-5		1.09	1.14	1.16	1.22	1.32
17.	SPV-102		1.09	1.11	1.15	1.23	1.31
18.	CS-3541		1.09	1.13	1.18	1.24	1.32
19.	2077-B		1.09	1.14	1.17	1.25	1.34
20.	CK 60-B		1.11	1.16	1.20	1.28	1.36
21.	CSH-1		1.13	1.17	1.24	1.31	1.42
S.E. $\pm$			0.014	0.013	0.011	0.012	0.016
C.D. at 5%			0.040	0.037	0.031	0.034	0.046

Table 17 : Average number of leaves per plant of different entries of sorghum during rabi 1978-79.

Sr. No.	Entry	Days after sowing	Average of three replications				
			12	18	24	30	36
1.	IS-5490		4.9	5.5	7.5	9.1	10.2
2.	M 35-1		4.8	5.4	7.3	9.0	9.9
3.	36 B		4.0	5.1	7.0	7.9	8.5
4.	1324		3.9	4.9	6.7	7.8	8.1
5.	HS-11		4.0	5.1	6.9	7.9	8.4
6.	1258 B		3.9	5.0	6.8	7.7	8.1
7.	GM-1-5 x IS-3922(393)		3.8	4.9	6.8	7.9	8.2
8.	PD-3-1-11		3.8	5.1	6.8	7.7	8.3
9.	HE-9		3.9	5.0	6.8	7.7	7.9
10.	1202 B		3.8	4.8	6.8	7.7	8.0
11.	SPV-115		3.7	4.9	6.8	7.6	8.2
12.	168		3.9	4.9	6.7	7.5	7.9
13.	SPV-104		3.8	4.8	6.6	7.5	8.0
14.	IS-84		3.6	4.7	6.7	7.6	8.2
15.	285		3.7	4.7	6.7	7.7	8.2
16.	CBH-5		3.6	4.6	6.5	7.3	7.7
17.	SPV-102		3.6	4.6	6.5	7.4	7.8
18.	CS-3541		3.8	4.6	6.4	7.4	7.7
19.	2077-B		3.5	4.5	6.4	7.3	7.6
20.	CK 60-B		3.5	4.3	6.1	7.1	7.5
21.	CBH-1		3.3	4.2	5.9	6.9	7.3
S.E. $\pm$			0.053	0.063	0.063	0.074	0.093
C.D. at 5%			0.151	0.180	0.180	0.211	0.265

**Table 18 : Silica ( $SiO_2$ ) contents (on dry matter basis) of plant at different stages of crop growth of different entries of sorghum.**

<b>Sr. No.</b>	<b>Entry</b>	<b>Percentage of <math>SiO_2</math> at 4th leaf stage</b>	<b>Percentage of <math>SiO_2</math> at 6th leaf stage</b>	<b>Percentage of dead hearts</b>
1.	IS-5490	18.05	19.97	16.80
2.	M 35-1	15.95	18.01	30.11
3.	36 B	12.64	17.36	33.58
4.	HS-11	9.82	15.02	49.92
5.	1258 B	12.31	17.47	50.33
6.	GM-1-5 x IS-3922(393)	8.78	16.42	50.62
7.	HS-9	12.40	17.34	54.24
8.	1202 B	11.60	16.50	57.63
9.	SPV-115	9.56	16.10	60.58
10.	168	6.45	12.24	61.70
11.	SPV- 104	10.01	14.35	62.84
12.	285	11.60	17.85	65.31
13.	CSH-5	9.04	15.80	75.13
14.	SPV-102	7.31	13.40	75.81
15.	CS-3541	12.01	15.30	79.92
16.	2077-B	6.30	12.85	83.96
17.	CK 60-B	8.11	11.67	87.49
18.	CSH-1	10.65	13.95	88.58

**r = -0.57**  
**'t' test at 5%**  
**significant**

**r = -0.78**  
**'t' test at 5%**  
**significant**

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