

# **Pearl Millet Improvement Program Pathology**

**Report of Work on Ergot and Smut  
Identification, Development, and Utilization of Resistance  
June 1980 to May 1981**



**ICRISAT**

**International Crops Research Institute for the Semi-Arid Tropics  
ICRISAT Patancheru P O.  
Andhra Pradesh 502 324, India**

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## ERGOT &amp; SMUT TEAM

R.J. Williams	:	Sub-Program Leader (On 1 yr sabbatical leave from Sep'80)
R.P. Thakur	:	Project Scientist
V.P. Rao	:	Technical Assistant (Ergot)
K.V. Subba Rao	:	Technical Assistant (Smut)
P. Anantha Rao	:	Field Assistant
Md. Azeez	:	Field Assistant
G.Ch.S. Raju	:	Clerk/Typist (Until Nov'80)
N.K. Ganapathy	:	Clerk/Typist (from Dec'80)
Tahir Ali Khan	:	Driver-Cum-General Assistant-II
S.K. Mohiuddin	:	Driver-Cum-General Assistant-I

## 2. INTRODUCTION

This report summarises the results of the projects on Identification, Development and Utilization of resistance for Ergot and Smut for the period June 1980 to May 1981. The major emphasis was on identification of new sources of resistance by screening germplasm lines and brooding materials, developing the levels of resistance and widening the genetic base of resistance by intermating the identified resistant lines and selecting plants in the segregating generations in the respective disease nurseries, testing the stability of resistance through multi-locational testing, and finally assisting brooders in utilizing the resistance sources in developing disease resistant cultivars. Accordingly the results are presented under three main headings, identification, development, and utilization of resistance for each disease.

A separate book, in limited number has been prepared, which contains Appendix-tables with detailed ergot and smut reactions of individual entries, for distribution to the pearl millet scientists. Anybody else interested in detailed information should consult this book in the library or may consult RPT.

### 3. ERGOT

3.1 Identification of Resistance This involves large-scale field screening of germplasm lines and breeding materials at ICRISAT Center at the initial and advanced stages, identifying resistance sources, and determining the stability of resistance through multi-locational testing.

#### 3.1.1 Initial Screen:

Germplasm lines: Of 172 germplasm lines from Tamil Nadu (obtained from Dr. S.A. Rao, ICRISAT Pearl Millet Germplasm Botanist) screened during the 1980 rainy season, no line was ergot-free, only one line had less than 10% ergot and 89% of the lines had more than 50% ergot (Table 1). Many individual inoculated plants which scored low ergot were not selected because of extremely poor seed set. The individual entry reactions are presented in Appendix I.

ICRISAT Center generated breeding lines: A total of 535 breeding lines from 15 breeding trials including hybrids, inbreds, synthetics, and experimental varieties were screened under moderate ergot pressure (Open-head inoculation) during the 1980 rainy season. No line was highly resistant, only 8% of the lines (mainly from UPN I & UPN II) scored between 1 and 10% ergot, 79% of the lines scored between 11 and 40% ergot, and the remaining lines had more than 40% ergot (Table 2). The detailed information on individual entry performance have already been supplied to the respective breeders and are also presented in Appendix II.

All India Coordinated Millet Improvement Project (AICMIP)

trial entries: A total of 161 entries from 6 trials including hybrids, populations, inbreds, male-steriles and local collections were screened under moderate ergot pressure except the male steriles and the local collections where inflorescences were bagged before inoculation. The trial wise results are summarised in Table 3. Among the hybrids, MBH 130, HHB 40, MBH 117 and ICH 226 scored between 12 and 20% ergot while BJ 104 had 50% ergot. Among the populations IVS 5454 scored least ergot (10%) while WC-C-75 scored 24% and Joli-1 was the highly susceptible with 57% ergot. All the male steriles and locals were highly susceptible (> 30% ergot). The entry wise detailed ergot reactions have already been made available to the AICMIP scientists and are also presented in Appendix III-V.

The 1980 International Pearl Millet Downy Mildew Nursery (IPMDN)

Of the 45 entries screened, no entry had less than 30% ergot. The mean ergot severity ranged between 30 and 96% (Table 4).

The 1980 International Pearl Millet Smut Nursery (IPMSN): Of the 32 entries screened, only 3 entries (EB 117-4-3-S-2-2-DM-1, EBS 137-2-S-1-DM-1, and J 2222-S-1-3) had less than 20% ergot and the remaining entries had mean ergot severities between 24 and 75% (Table 5).

Others:

SC-2(M)5-4 selections: Fourteen selections from this line were evaluated during the post-rainy season. The mean ergot severity ranged from 1 to 77%. Four promising entries were selected for further evaluation.

Gen. plasma selections: Nineteen selections from periplasm lines were evaluated. The mean ergot severity ranged from 10 to 54% compared to 58% in the check ICH 105. There were wide variabilities for ergot reactions within lines.

### 3.1.2 Advanced Screen

Selections from the 1979 initial screen: Seventy four single heads/lines selected from the 1979 screen were screened during the 1980 rainy season. Seven lines had less than 20% ergot and the remaining 67 lines had mean ergot severities in the range of 21 to 82%. About 30 ergot less susceptible (< 2% ergot) single plants were selected for further evaluation. The detailed ergot reactions of individual entries are provided in Appendix VI-VII.

Pearl Millet Ergot Nursery (PMEN): Promising selections, not included in the multilocational testing, are evaluated in a replicated trial in this nursery. A 37-entry PMEN was evaluated at the Center. Six entries or their selections had mean ergot severities of not more than 10%, and the remaining 21 entries scored between 11 and 64%, while the susceptible check BJ 104 had 72% ergot. The detailed ergot reactions are presented in Appendix VIII. About 100 ergot-free single heads from 26 lines were selected for further evaluation.

### 3.1.3 Multilocational Testing

The 1980 International Pearl Millet Ergot Nursery (IPMEN): The 32 entry IPMEN, which included 20 ICRISAT Center developed ergot resistant F<sub>5</sub> lines and 12 promising lines from the 1979 IPMEN and advanced screens, were evaluated at 2 West African and 7 Indian locations. Five entries,

ICMPE 140-3, ICMPE 192-16, ICMPE 193-7, 700418-1-E-2-DM-3, and SC-2(M)S-4-E-1-6 were promising with across locations mean ergot severities of not more than 10%, compared with 35% in the trial Check BJ 104 (Table 6). Several of the ergot resistant F<sub>5</sub> lines (ICMPE Nos) were promising at Indian locations but not at Samaru, Nigeria, probably due to existence of variable pathogen populations. The detailed report on th 1980 IPMEN has already been prepared and distributed to the scientists.

### 3.2 Development of Resistance:

Progenies from crosses between ergot low susceptible lines were screened and promising lines were selected both in the rainy and post-rainy seasons of 1980-81.

#### The 1980 rainy season:

F<sub>6</sub> lines: Five hundred seventy two single plants selected from F<sub>5</sub> lines in the 1979-80 post-rainy season screen, were evaluated in four trials (F<sub>6</sub> I-IV). More than 2600 ergot-free single plants were selected from 195 F<sub>6</sub> lines for further evaluation. The detailed ergot reactions are presented in Appendices IX - XII.

F<sub>5</sub> lines: Of 64 lines evaluated, 16 were promising and 51 ergot-free single plants were selected. The detailed ergot reactions are presented in Appendix XIII.



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F<sub>5</sub> lines: Of 64 lines evaluated, 16 were promising and 51 ergot-free single plants were selected. The detailed ergot reactions are presented in Appendix XIII.

Thirty promising F<sub>4</sub> lines were evaluated as F<sub>5</sub> both for ergot and smut. The mean ergot severities ranged from 6 to 81% compared with 91% in BJ 104. Since these lines were not highly resistant to ergot, no selections were made. The detailed ergot reactions are provided in Appendix XIV.

F<sub>1</sub> lines: In order to further concentrate the resistance during the 1979-80 post-rainy season crosses were made between ergot resistant F<sub>5</sub> lines, and 8 F<sub>1</sub> lines were evaluated and their seed increased.

#### The 1980-81 post-rainy season

F<sub>7</sub> bulk: One hundred sixteen F<sub>6</sub> line-bulks were evaluated as F<sub>7</sub> lines in replicated trials. The results are summarised in Table 7. Although no line was ergot-free, 63 of the 116 lines had mean ergot severities in the range of 1 to 10% and 81% of the lines had ergot in the range of 1 to 20%, compared to 86% ergot in BJ 104. Under open-head inoculations many of these lines were ergot-free while in some lines the ergot severity ranged between 0 and 8% compared with 52% in BJ 104. Many of these ergot resistant lines showed high levels of resistance to downy mildew and rust too. The detailed reactions are provided in Appendix XV. Based on ergot reactions and agronomic scores 36 promising lines were selected of which 13 lines were promising in both replications.

F7 lines: A total of 373 F<sub>6</sub> single plant progenies were screened as F<sub>7</sub> lines in 5 trials. The trial wise results are summarised in Table 8. The mean ergot severities of 373 F<sub>7</sub> lines ranged from less than 1 to 69% compared with 86% in BJ 104. Under open-head inoculation the ergot severity ranged between 0 and 1% compared with 52% in BJ 104. Of 149 lines selected from these trials, 80 were promising in both replications. The detailed ergot reactions of individual lines are provided in Appendix XVI.

A summary of the progress made from F<sub>2</sub> to F<sub>7</sub> generation in developing ergot resistance is provided in Table 9. It appears that single plant selection at F<sub>6</sub> and beyond may not be useful in further increasing the levels of resistance.

F<sub>6</sub> bulk: Ten F<sub>5</sub>-line-bulks were evaluated in a replicated trials. The mean ergot severities ranged from 10 to 56% in F<sub>6</sub> bulks compared with 91% in BJ 104. Under open-inoculation these lines exhibited high levels of resistance (< 1% ergot) compared with 51% in BJ 104. Five promising lines were selected for further evaluation.

F<sub>6</sub> lines: A total of 51 F<sub>5</sub> single plant selections were evaluated as F<sub>6</sub> lines. About 45% the lines scored ergot between less than 1 and 20% and only 6% of the lines had more than 50% ergot. Under open-head inoculation, the ergot severities ranged from 0 to 1%. The progress made in developing ergot resistance in the set of crosses is presented in Table 10.

F<sub>6</sub> ergot-smut selections; From 30 ergot low susceptible F<sub>5</sub> lines screened for smut reactions at Hissar during the 1980 rainy season, 77 smut resistant plants were selected. These 77 plants were evaluated for ergot reactions as F<sub>6</sub> lines. The mean ergot severities ranged from 1 to 72% and 26 promising lines were selected for further evaluation. The detailed reactions are presented in Appendix XVII.

F<sub>3</sub> lines: A total of 226 F<sub>3</sub> lines from crosses between ergot low susceptible lines, were evaluated. About 65% of the lines had ergot in the range of 0 to 20% and only about 3% of the lines had more than 50% ergot. The progress made from F<sub>1</sub> to F<sub>3</sub> is indicated in Table 11.

The detailed reactions are provided in Appendix XVIII.

F<sub>2</sub> populations: Eight F<sub>2</sub> populations generated from crosses between ergot resistant F<sub>5</sub> lines were evaluated. For each population about 500 plants were inoculated and 100 inoculated plants were scored. The detailed reactions and frequencies are presented in Table 12. A total of 181 single plants were selected for further evaluation.

#### Selection of plants with overlapping of protogyny and anthesis:

Most of the ergot resistant lines, developed through intermating ergot low susceptible lines and selecting resistant plants at each generation under artificial inoculation screening, have shorter protogyny with anthesis commencing at 40-80% fresh and receptive stigma stage in the individual bagged heads compared to the highly ergot susceptible

hybrids and varieties where anthesis commences after more than 95% stigmas are withered, under similar situation. Now if this short protogyny-early anthesis is one of the factors contributing to ergot resistance then individual plants with this trait may be selected and evaluated for ergot resistance. During the 1980-81 post-rainy season screening, we observed hundreds of individual plants and selected more than 500 plants with this trait. These individual plants will be grown in the 1981 rainy season and their progenies will be evaluated for their ergot reactions in relation to short protogyny trait.

#### Evaluation of F<sub>6</sub> and F<sub>7</sub> bulks:

During the rainy and post-rainy seasons of 1980-81, 27 line bulks of ergot resistant F<sub>6</sub> and F<sub>7</sub> lines were grown in replicated trials. High ergot pressure was created by spray inoculating the crops at protogyny flowering period with honeydew conidial suspension using Knap-sac power sprayer. Inoculations were done daily in the evening hours for 4-6 days until the stigmas remained fresh. Overhead sprinkler irrigation was provided for 30 min twice a day on rain-free days throughout the flowering period to create high humidity.

Ergot incidence (% infected inflorescence/plot) and ergot severity (% infected florets/inflorescence) were determined for each entry. BJ 104 and WC-C 75 were used as checks. The trial wise results are presented below.

Trial 1: Ten ergot resistant F<sub>6</sub> bulk lines were evaluated during the rainy season 1980. The mean ergot incidence ranged from 2 to 14% in ergot resistant lines compared with 36% in WC-C 75 and 66% in BJ 104 and the mean ergot severities ranged from 0.1% to 1.5% in ergot resistant lines compared with 4.1% in WC-C 75 and 14% in BJ 104 (Table 13). These lines also had high levels of resistance to smut at Hissar.

Trial 2: Nine ergot resistant F<sub>6</sub> lines were evaluated during the 1980-81 post-rainy season. The mean ergot incidence varied from 0 to 1.5% in ergot resistant lines compared to 48% in BJ 104. The mean severities varied from 0 to 0.05% in resistant lines compared to 9.1% in BJ 104 (Table 14).

Trial 3: Eight ergot resistant F<sub>7</sub> lines were evaluated in the 1980-81 post-rainy season. Mean ergot incidence and severities were almost negligible in resistant lines compared to 37% and 54% incidence and 9.3% and 23.1% severities in NC-C-75 and BJ 104 respectively (Table 15).

Under near natural very high ergot pressure (created by repeated spray inoculations) in the field, these lines hold very high levels of resistance. It seems therefore that resistance in these lines will be quite effective under natural high ergot pressure in a crop. These lines could be multiplied in isolation plots and seed made available for further utilization.

### 3.3 Utilization of developed resistance:

Hybrid reduction: During the 1979-80 post-rainy season Dr. D.S. Talukdar and team made 642 test crosses on three ms lines (111A, 5054A and 5141A) using 277 individual plants from 30 ergot low susceptible F<sub>5</sub> lines. These F<sub>1</sub> hybrids and parents were evaluated during the 1980 rainy season in a single 4 m row plot for each entry. About 40 inflorescences were inoculated in each hybrid and parents and 10 random inflorescences/entry were scored for ergot reactions.

The results are summarised in Table 16. All the F<sub>1</sub> hybrids were highly susceptible, with mean ergot severities ranging from 63 to 98%. The mean ergot severities on ms lines varied between 76 and 83% while on ergot low susceptible F<sub>5</sub> lines varied between < 1 and 20%. The results, thus indicate that to get resistance in F<sub>1</sub> hybrid, ergot resistance in both the parents is required.

In an attempt to incorporate resistance in A lines, ergot low susceptible F<sub>4</sub> lines were crossed to B lines by Dr. K. Anand Kumar and 14 such F<sub>2</sub> populations were evaluated during the 1980-81 post-rainy season for ergot reactions, and only 73 single heads with <2% ergot (i.e. 1.3% of the inoculated heads) were selected. These selected heads will be tested as F<sub>3</sub> progenies and also will be back-crossed to B lines and test crossed to A lines to check their maintaining ability and possibilities of transferring resistance into A lines. Some more crosses have been made by KAK between B lines and ergot resistant F<sub>6</sub> lines.

Crosses have also been made between ergot resistant F<sub>7</sub> lines and established R lines by BST in order to transfer resistance in established R lines.

Development of Synthetics: Using 12 ergot resistant F<sub>5</sub> lines, 3 synthetics ICMS 8031, ICMS 8032 and ICMS 8034 were constituted by Dr. S.B. Chavan during the 1979-80 post-rainy season. These were evaluated for ergot reactions during the 1980 rainy season. The results are presented in Table 17. These synthetics developed less ergot (12-15%) than the check variety WC-C-75 (24% ergot). It appears that developing ergot resistant synthetics will be easier than resistant hybrids and these synthetics will be more useful for West African countries. Since the yield potentials of these synthetics are not high, attempts are being made to increase their yield while maintaining ergot resistance.

#### 4. SMUT

4.1 Identification of resistance: This involves screening pearl millet lines in three phases - initial screen, advanced screen and multilocational testing. The initial and advanced screens are carried out at ICRISAT-Hissar subcenter during the rainy season and stability of resistance is determined through multilocational testing.

##### 4.1.1 Initial Screen:

ICRISAT Center breeding lines: A total of 396 entries in 12 trials were evaluated. The trial wise results are summarised in Table 18. Generally, hybrids were highly susceptible (>20% smut). Some of the experimental varieties and hybrid male parents (in DONIAH) showed less susceptibility to smut (< 10%). Eighteen of the 21 IPMAT-6 entries developed more than 30% smut. On the whole, more than 58% of the entries had more than 30% smut. The detailed reactions of individual entries are presented in Appendix II.

AICMIP trial entries: In four trials, 73 hybrids and populations were evaluated. The results are summarised in Table 19. Thirty two of the 45 hybrids had more than 30% smut and no hybrid scored below 11% smut. Among populations, only 6 of the 28 entries scored more than 30% smut, although no entry scored below 11% smut. Fifteen entries scored between 11 and 20% smut. The detailed individual entry reactions are presented in Appendix III.

International Pearl Millet Ergot Nursery (IPMEN): Four of the 32 entries were smut-free, 13 entries had only upto 1% smut, 9 entries had smut in the range of 2 to 5%, and only 1 entry had 35% smut compared to 60% smut on the susceptible check ICH 105 (Table 20).



International Pearl Millet Downy Mildew Nursery (IPMDN): Of 45 entries, no entry was smut-free, 22 entries had smut between 1 and 10%, and the remaining 23 entries scored smut in the range of 11 to 36%, while the susceptible check ICH 105 had 60% smut (Table 4).

Ergot low susceptible F<sub>5</sub> lines: Thirty F<sub>5</sub> lines, which were selected as ergot low susceptible at the Center during 1979-80 post-rainy season ergot screening, were screened for smut resistance at Hissar during the 1980 rainy season. It is encouraging to note that 2 of the 30 lines were smut-free, 9 lines had maximum upto 1% smut, 15 lines had smut between 2 and 9%, and the remaining 3 lines scored more than 10% smut while the susceptible check BJ 104 scored 54% smut. These lines were evaluated for ergot reactions also. The combined data for ergot and smut are provided in Appendix XIV.

Ergot low susceptible F<sub>6</sub> bulk: Ten ergot low susceptible bulk lines, which were evaluated for their ergot reactions in a replicated trial at the Center under open-head inoculation conditions, were also evaluated for their smut reactions at Hissar during the 1980 rainy season. Three of the 10 lines were smut-free, 4 lines had not more than 1% smut and the remaining 3 lines had between 3 and 4% smut, while the susceptible check BJ 104 had 44% smut (Table 13).

Gen. : lasm lines: About 300 germplasm lines from West Africa (Senegal & Niger) were planted but because of poor plant stand and poor growth in a bad field these could not be screened.

#### 4.1.2 Advanced Screen:

Selections from the 1979 screen: A total of 261 single heads selected from the 1979 initial screen were screened in 3 trials. The results are summarised in Table 21. About 11% of the entries were smut-free, 29% of the entries had maximum upto 1% smut, 23% of the entries developed upto 5% smut and only about 12% of the entries had more than 20% smut. About 500 smut-free single heads were selected from 71 entries for further evaluation. The detailed reactions of individual entries are presented in Appendix XIX.

Pearl Millet Smut Nursery (PMSN): Selections from the 1979 advanced screens, which were not included in the International Pearl Millet Smut Nursery (IPMSN), were screened in a replicated trial. Of 38 entries, 3 were smut-free, 25 entries had not more than 1% smut and the remaining 10 entries had smut between 2 and 11% while the check BJ 104 had 37% smut (Table 22). About 270 smut-free single heads were selected for further evaluation.

#### 4.1.3 Multilocational Testing:

The 1980 International Pearl Millet Smut Nursery (IPMSN): The 32 entry IPMSN which included promising entries from the 1979 IPMSN, the 1979 PMSN, and the 1979 advanced screens were tested at 7 locations in India and West Africa. The detailed report has already been prepared and distributed to the scientists. (Report on the 1980 IPMSN). This report, however, does not include the data from Sapu, Gambia which we received very late. A summary result including the data from Sapu is presented in Table 23.

#### 4.2 Development of smut resistance:

In an attempt to rapidly build-up high levels of smut resistance, 13 lines identified as apparently less susceptible to smut in the 1977 screens at Hissar were intermated in the 1977-78 post rainy season to obtain 117 F<sub>1</sub> lines. Some of these F<sub>1</sub> lines were screened in 1978 and 117 F<sub>2</sub> populations were screened during the 1979 rainy season at Hissar. At F<sub>3</sub>, 166 lines were screened during the 1980 rainy season. The progress made in improving the levels of resistance at each generation is quantified in Table 24. More than 500 smut-free single heads have been selected from 89 promising F<sub>3</sub> lines for further evaluation. The detailed smut reactions of individual lines are presented in Appendix XX.

Four F<sub>2</sub> populations and four F<sub>1</sub> lines from crosses involving smut high resistant lines were evaluated and more than 100 smut-free single heads from F<sub>2</sub> populations were selected for further evaluation.

#### 4.3 Utilization of smut resistance:

Improvement in agronomic traits: 1. During the post-rainy season 1977-78 Dr. B.S. Talukdar generated 50 F<sub>1</sub> lines by intermating 2 smut low susceptible lines and 27 agronomic elite inbreds. Pedigree selection continued in each generation under artificial inoculation screening at Hissar. During the 1980 rainy season 40 F<sub>3</sub> lines were evaluated. The results are summarised in Table 25. Ten of the 40 lines were smut-free, 17 lines had maximum upto 1% smut and only 1 line had more than 20% smut. Many of these lines appear to possess good agronomic traits with high levels of smut resistance. More than 150 smut-free single heads were selected for evaluation at F<sub>4</sub>.

2 Dr. Anand Kumar generated 14 F<sub>1</sub> by crossing between a high tillering line EC 298-3 and 5 smut resistant lines and their F<sub>2</sub> populations and smut resistant parents were evaluated during 1980 rainy season at Hissar. The mean smut severities of populations ranged from less than 1 to 16%; the smut resistant parents scored smut between less than 1 to 5% while the Check BJ 104 scored 44% (Table 26). About 80 smut-free single heads were selected from 9 F<sub>2</sub> populations for further evaluation at the F<sub>3</sub> stage.

#### Utilization in hybrid:

1. Eight F<sub>2</sub> populations from crosses involving 23 D<sub>2</sub>B and five smut resistant lines (made by KAK) were evaluated and 73 smut-free single heads were selected. The results are presented in Table 27. These selections were grown at ICRISAT Center in summer 1981 and 58 test crosses on 81-A were made by KAK. These test crosses and F<sub>4</sub> lines will be evaluated at Hissar during the 1981 rainy season.

2. BST made 60 F<sub>1</sub> hybrids between 3 ms lines 111A, 5141A and 5054A, and 10 smut resistant lines during the summer 1980 at ICRISAT Center and these hybrids and parents were screened at Hissar during the 1980 rainy season. The results are presented in Table 28. The mean smut severities ranged from 1 to 78% for the hybrids. Thirteen hybrids scored less than 9% smut. All the three ms lines and their B lines were highly susceptible with mean smut severities between 47 and 86%. These 13 F<sub>1</sub> hybrids will be rescreened during the 1981 rainy season for confirmation.

#### Utilization in composites:

During the 1978 summer Dr. S.C. Gupta constituted a composite using 37 smut low susceptible lines at the Center. Five hundred and sixty two half-sib progenies in two smut resistant composites

(SRC I & SRC II) were screened during the 1980 rainy season at Hissar. The results are summarised in Table 29. About 78% of the entries developed not more than 10% smut and only about 4% of entries had more than 20% smut. More than 700 smut-free single heads from 117 entries were selected. These were grown by Dr. P. Singh during 1981 at the Center and about 300 S<sub>1</sub> have been selected for further screening at Hissar during the 1981 rainy season.

Table 1 Summary of ergot reactions of 172 germplasm lines (from Tamil Nadu, India) during the 1980 rainy season at ICRISAT Center.

Ergot severity <sup>a/</sup> (%) Class	No. of lines	Percentage of lines
< 1	0	0
1-10	1	0.6
11-20	0	0
21-30	1	0.6
31-40	8	4.6
41-50	9	5.2
>50	153	89

<sup>a/</sup> Based on mean ergot severities of 10-15 inoculated heads under pollen protection

Table 2. Summary of ergot reactions<sup>a/</sup> of ICRISAT breeding materials during the 1980 rainy season at the ICRISAT Center.

Trials	No. of entries	No. of entries in the ergot severity <sup>a/</sup> (%) Class						
		<1	1-10	11-20	21-30	31-40	41-50	>50
PMHT	25	0	5	11	5	3	1	0
PMHT (P)	24	0	1	3	8	4	3	5
PMIHT-1	36	0	0	10	18	3	1	4
PMIHT-2	36	0	1	6	13	9	2	5
PMIHT-3	36	0	0	13	15	3	4	1
PMIHT-4	36	0	0	5	17	11	3	0
IPMAT-6	21	0	0	8	13	0	0	0
ELVT	32	0	0	2	22	6	2	0
EVT	32	0	0	15	13	4	0	0
D <sub>2</sub> DVT	10	0	0	1	1	3	4	1
PMST	20	0	0	4	8	7	1	0
PMIST	49	0	2	16	20	7	2	2
UPN-I	89	0	15	20	26	12	8	8
UPN-II	86	0	20	40	11	3	4	8
MS Lines	3	0	0	0	0	0	0	3
<b>Total</b>	<b>535</b>	<b>0</b>	<b>44</b>	<b>154</b>	<b>190</b>	<b>75</b>	<b>35</b>	<b>37</b>
<b>% of entries</b>	<b>-</b>	<b>0</b>	<b>8</b>	<b>29</b>	<b>36</b>	<b>14</b>	<b>16</b>	<b>7</b>

a/ Mean ergot severities of 10-20 open inoculated inflorescences.

Table 3. Summary of ergot reactions of All India Coordinated Millet Improvement Project Trial entries during the 1980 rainy season at ICRISAT Center

Trial	No. of entries	No. of entries in the ergot severity <sup>a/</sup> class				
		<1	1-10	11-20	21-30	>30
IPMHT-1	21	0	0	2	5	14
APMHT-II	26	0	0	2	7	17
IPMPT-IV	15	0	1	2	4	8
APMPT- V	15	0	0	2	3	10
Male Steriles	44	0	0	0	0	44
Locals	40	0	0	0	0	40
<b>Total</b>	<b>161</b>	<b>0</b>	<b>1</b>	<b>8</b>	<b>19</b>	<b>133</b>
<b>Percentage of entries</b>		<b>0</b>	<b>0.6</b>	<b>5.0</b>	<b>11.8</b>	<b>82.6</b>

IPMHT - Initial Pearl Millet Hybrid Trial

APMHT - Advanced Pearl Millet Hybrid Trial

IPMPT - Initial Pearl Millet Population Trial

APMPT - Advanced Pearl Millet Population Trial

<sup>a/</sup> Mean ergot severity of 10-20 inoculated inflorescences under no pollen protection except male steriles and locals where inflorescences were bagged before inoculation.



Table 4 Ergot, smut, and downy mildew (DM) reactions and days to 75% flowering (DTF) of the 45 entry IPMDMN during the 1980 rainy season

Sl No	Entry	Mean <sup>a/</sup> Ergot severity (%)	Mean <sup>b/</sup> Smut severity (%)	DM severity (%)
1.	IP-1930	30	19	<1
2.	700792	35	1	0
3.	75-Series-1	36	2	4
4.	700590	39	10	0
5.	IVS-8038	49	8	<1
6.	700516	54	13	<1
7.	700546	55	29	0
8.	EB 18-3-1	55	12	1
9.	P-7	56	25	<1
10	R-238-1-2-1	63	4	2
11	MPP-7147-2-1	63	6	<1
12	T-128-3 x 700404-1-5-5	63	6	1
13	700619	67	24	7
14	700633	67	28	<1
15	NC-7158	67	25	1
16	700512	68	5	<1
17	700651	68	6	0
18	J-215-1	70	2	<1
19	SSC-7218	71	7	0
20	IP-2058	72	23	<1
21	J-1593	73	9	2
22	NC-7174	74	1	0
23	700335	76	15	6
24	J-92-1	76	34	0
25	IP-2037	76	11	<1
26	IVS-8172	76	3	<1
27	7042	77	-	58
28	2898-109-1	77	8	3
29	700780	78	7	0
30	J-76	78	3	2

contd..

Sl No	Entry	Mean <sup>a/</sup> Ergot severity (%)	Mean <sup>b/</sup> Smut severity (%)	DM severity (%)
31	F <sub>4</sub> FC-1474-2-2-2	78	1	4
32	700251	79	26	<1
33	SDN-714	79	3	0
34	WC-8220	79	17	<1
35	K-1486 x 700787-2-10	80	3	0
36	EB-83-2	81	27	<1
37	ICH-241	82	30	13
38	NELC 8010	85	8	1
39	700706	86	11	0
40	E 298-2-1-8	87	11	<1
41	BJ 104	88	49	43
42	ICH-165	90	36	1
43	ICH-226	90	22	2
44	SDN-503	94	12	2
45	EB-79-2-2 x EB 59-3-1	96	9	<1
	ICH 105 Check	91	60	0

a/ Mean of 10 bagged-inoculated-bagged heads at ICRISAT Center

b/ Mean of 10 bagged-inoculated heads at Hissar

c/ Screened in DM nursery at ICRISAT Center.

Table 5 Ergot, smut, and downy mildew (DM) reactions, and days to 75 percent flowering (DTF) of the 1980 IPMSN entries during the 1980 rainy season at ICRISAT Center

Entry	DTF	Smut <sup>a/</sup>	Ergot <sup>b/</sup>	DM <sup>c/</sup>
ICI 7517-S-1	62	0	63	0
SSC FS 252-S-4	55	0	28	0
EB 112-1-S-1-1	49	0	43	0
EB 15-1-S-3-1	58	<1	33	0
NEP 588-5690-S-8-4	58	<1	37	1
IP 2789-S-2	52	<1	33	20
SAR 466-S-1-DM-1	53	<1	56	4
EB 117-4-3-S-2-2-DM-1	58	<1	1	0
EBS 137-2-S-1-DM-1	60	<1	10	36
EB 132-2-S-5-2-DM-1	52	<1	44	7
EB 237-2-S-3	50	<1	38	2
J 2222-S-1-3	57	<1	14	0
WC FS 151-S-1-1	53	1	51	0
EBS 119-2-1-S-1-1	50	1	66	1
700130-S-1-DM-1	56	1	27	5
J1974-S-2-3	52	1	51	3
EB 24-1-S-5	53	1	49	2
EB 218-1-S-2	56	1	53	0
EB 137-1-2-S-3	51	1	54	0
EB 80-1-1-S-5	59	1	24	1
J 2226-S-1-1-DM-1	51	2	63	0
EB 142-1-1-S-2-1	54	2	60	2
EB 209-1-6-S-7	51	2	38	2
EB 229-4-1-S-6-1	53	2	68	2
EBS 70-1-S-4-3	55	3	61	2
WC FS 142-S-1-1	54	3	67	5
EB 54-1-1-S-7-3	52	3	33	0
J 797-1-S-3	50	4	59	1
EBS 46-1-2-S-2	50	4	49	2
P-10-S-1	50	9	55	1
P-20-S-1	56	9	42	2
3/4 ExBornu 220-S-1-DM-1	50	38	75	0
Local-Resistant (SSC FS- 252-S-2-DM-4)	51	1	57	-
- Susceptible (ICH 105)	50	57	85	-
Trial Check (BJ-104)	44	61	86	40

a/ Mean of 40 inoculated-bagged heads in two replications and each datum is rounded off to the nearest whole number

b/ Mean of 40 bagged-inoculated-bagged heads in two replications

c/ Mean of 2 replications

Table 6. Mean ergot severity (%)<sup>2/</sup> of the 1980 IPMEN entries and the local checks at 9 locations with across location entry means and across entries locations means

Entry	Mean ergot severity (%)									Over all mean
	ICRISAT Center	Jam- nagar	Kan boinso	Hls sar	Pune	Delhi	Madhi- nagar	anna	Sa- nall ru	
SC-2(M)5-4-E-1-6	<1	10	5	5	5	5	5	12	14	7
700448-1-E-2-DM-3	<1	1	3	11	9	7	10	9	22	8
ICMPE 193-7	<1	2	5	7	12	6	9	18	33	10
ICMPE 192-16	<1	11	22	0	8	5	6	20	22	10
ICMPE 140-3	<1	3	5	25	7	10	2	11	27	10
ICMPE 140-6	<1	<1	15	0	7	2	29	6	49	11
ICMPE 134-6	1	2	15	9	11	5	20	19	21	11
ICMPE 140-7	<1	1	13	0	6	10	14	35	21	11
ICMPE 13-6	<1	2	6	3	21	6	3	10	59	12
ICMPE 140-2	<1	7	13	0	12	15	20	16	27	12
ICMPE 192-2	<1	12	12	13	8	7	25	7	21	12
ICMPE 192-15	<1	11	15	0	9	6	19	30	18	12
ICMPE 192-5	<1	11	6	25	8	3	3	18	34	12
ICMPE 192-9	<1	10	8	1	7	3	8	48	22	12
ICMPE 143-4	<1	7	16	4	13	19	15	7	37	13
700457-E-1-DM-4	3	20	7	10	9	1	12	23	24	13
ICMPE 143-3	<1	3	10	0	12	17	4	25	52	14
ICMPE 13-2	<1	6	4	0	9	6	33	11	60	14
J 2238-2-E-4-1	<1	4	12	0	16	13	22	18	40	14
ICMPE 13-4	<1	12	4	15	5	8	24	13	49	14
ICMPE 134-5	<1	2	7	34	7	6	14	27	25	14
ICMPE 134-3	<1	2	3	68	9	5	6	16	37	16
ICMPE 192-12	<1	12	5	8	10	23	6	41	41	16
J 797-1-E-3-4	<1	14	5	0	15	37	9	14	42	16
ICMPE 140-1	<1	14	15	0	11	16	23	18	45	16
ExBouchi 700638-3-2										
-E-1-DM-4	<1	13	18	13	13	24	9	39	39	18
700489-1-E-1-DM-2	4	18	29	0	15	28	23	27	35	20
ND 2282-79-1-E-2-8-DM- -1-1	<1	30	8	27	17	32	3	37	27	21
700626-E-1-DM-3	1	9	22	26	21	20	7	20	58	21
700434-1-E-1-DM-1	2	16	6	47	10	26	12	45	29	21

Table 6 (Contd.)

700507-E-3-DM-1	2	25	8	0	21	27	28	47	43	22
700708-1-E-1-DM-1	2	8	11	9	20	46	16	51	39	22
Location mean <sup>c/</sup>	1	9	10	11	11	14	14	23	35	15
Local resistant	<1	29	10	0	26	62	20	59	35	27
Local susceptible	29	21	-	8	35	45	35	8	19	25
Trial Check (BJ-104)	36	21	19	0	33	66	48	26	66	35
No. of entries with < 10% ergot	32	18	18	21	17	18	15	5	0	5

a/ Each datum is the mean of 40 inoculated heads in 2 replications

b/ Entry mean across locations

c/ Location mean across entries

- data not provided

Table 7. Summary of performance of 116 F<sub>6</sub> line-bulks grown as F<sub>7</sub> lines and screened for ergot resistance in a replicated trial at ICRISAT Center during the 1980-81 post rainy season

Ergot severity (%) Class	Number of lines	Percentage of lines
<1	0	0
1-10	63	54.3
11-20	31	26.7
21-30	16	13.8
31-40	3	2.6
41-50	3	2.6
>50	0	0

Table 8. Summary of ergot reactions of 373 F<sub>7</sub> lines in 5 trials screened during the 1980-81 post rainy season at ICRISAT Center.

Ergot severity class	Number of lines in each severity class in trial					Total	% of lines
	I	II	III	IV	V		
<1	7	0	0	17	1	25	6.7
1-10	48	17	13	37	60	175	46.9
11-20	10	13	17	7	30	77	20.6
21-30	11	12	7	5	9	44	11.8
31-40	5	4	7	3	11	30	8.0
41-50	3	2	4	1	2	12	3.2
>50	2	1	0	0	7	10	2.7
<b>Total lines</b>	<b>86</b>	<b>49</b>	<b>48</b>	<b>70</b>	<b>120</b>	<b>373</b>	

Table 9. Summary of progress made in developing ergot resistant lines from F<sub>2</sub> to F<sub>7</sub> generations

Mean ergot severity class	Percentage of lines in each class at					
	F <sub>2</sub>	F <sub>3</sub>	F <sub>4</sub>	F <sub>5</sub>	F <sub>6</sub>	F <sub>7</sub>
<1	0	0	0	1	14	7
1-10	0	2	15	14	56	47
11-20	0	6	20	19	18	21
21-30	6	11	28	16	9	12
31-40	9	16	22	20	2	8
41-50	18	16	9	15	<1	3
>50	67	49	6	16	0	2

F<sub>2</sub> - pooled data from 33 pop; number of lines tested in subsequent generations F<sub>3</sub> = 657, F<sub>4</sub> = 472, F<sub>5</sub> = 220, F<sub>6</sub> = 572 and F<sub>7</sub> = 373



Table 10. Summary of progress made in developing ergot resistance in the second set of crosses From F<sub>1</sub> to F<sub>6</sub> generations

Mean ergot severity (%) Class	Percentage of lines in each severity class at generations of testing					
	F1	F2	F3	F4	F5	F <sub>6</sub>
< 1	2	0	0	0	6	2
1-10	9	0	1	4	59	18
11-20	13	0	8	8	27	23
21-30	14	6	15	23	4	29
31-40	16	19	23	15	0	12
41-50	8	32	26	28	2	10
> 50	38	43	27	22	2	6

No. of lines (crosses) screened: F<sub>1</sub> = 130 lines (51 crosses)

F<sub>2</sub> = 127 populations (51 crosses)

F<sub>3</sub> = 136 lines (33 crosses)

F<sub>4</sub> = 83 lines ( 8 crosses)

F<sub>5</sub> = 64 lines ( 2 crosses)

F<sub>6</sub> = 51 lines ( 2 crosses)

Two crosses: 700590 x 3/4 ExBornu 77-2-1

700687 x 3/4 ExBornu 77-2-1

Table 11. Progress in developing ergot resistant lines from F<sub>1</sub> to F<sub>3</sub> generations

Ergot severity (%) <sup>a/</sup> Class	% of ontries in each severity <sup>b/</sup> class		
	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>
<1	0.0	0.0	2.2
1-10	29.6	10.3	39.8
11-20	31.0	10.3	23.0
21-30	14.1	38.0	18.1
31-40	11.3	27.6	6.6
41-50	8.4	13.8	7.1
>50	5.6	0.0	3.1

a/ based on 10-40 bagged-inoculated heads

b/ F<sub>1</sub> = 71 lines, F<sub>2</sub> = 29 lines, F<sub>3</sub> = 226 lines

Table 12. Ergot reactions of Parents, F<sub>1</sub> and F<sub>2</sub> populations

Pedigree	Ergot reactions (%)	
	mean sev.	range
P <sub>1</sub> - (J 606-2 x J 703-1)-4-4-5-6	<1	0-5
P <sub>2</sub> - (J2238 x J2210-2)-3-3-4-6	<1	0-2
P <sub>3</sub> - (J2238 x J2210-2)-3-3-10-7	<1	0-5
P <sub>4</sub> - (700619 x 700599)-3-2-11-5	2	0-10
P <sub>5</sub> - (700619 x 700599)-3-2-11-2	3	0-10

  

	Ergot reactions			
	F <sub>1</sub>		F <sub>2</sub>	
	mean	range	mean	range
P <sub>1</sub> x P <sub>2</sub>	3	0-40	22	0-80
P <sub>2</sub> x P <sub>1</sub>	13	0-85	32	0-85
P <sub>1</sub> x P <sub>4</sub>	5	0-45	35	1-85
P <sub>4</sub> x P <sub>1</sub>	11	0-60	40	1-90
P <sub>2</sub> x P <sub>4</sub>	12	0-40	34	0-85
P <sub>4</sub> x P <sub>2</sub>	6	0-25	35	1-85
P <sub>3</sub> x P <sub>4</sub>	18	0-70	57	1-90
P <sub>5</sub> x P <sub>3</sub>	14	0-50	59	10-90

P<sub>1</sub>-P<sub>5</sub> = mean of 30 inoc. heads in 3 reps. post rainy season 1979-80

F<sub>1</sub> = mean of 40 inoculated heads; F<sub>2</sub> = mean of 100 inoc. heads of the 500 inoc. heads/population

Table 13. Performance of the 10 ergot resistant F<sub>6</sub> bulk lines in a replicated trial under artificial ergot pressure (open head inoculations) during the 1980 rainy season at ICRISAT Center

Entry	Ergot reactions		
	Mean <sup>a/</sup> inci- dence (%)	Mean <sup>b/</sup> severity (%)	Mean <sup>c/</sup> smut sev. (%)
ICMPE 13-4	2	0.1	3
ICMPE 13-6	9	0.7	4
ICMPE 134-3	3	0.2	<1
ICMPE 134-6	5	0.3	0
ICMPE 140-1	14	1.5	1
ICMPE 140-2	4	0.4	<1
ICMPE 140-3	9	0.6	3
ICMPE 140-6	2	0.3	0
ICMPE 140-7	3	0.1	0
ICMPE 192-5	11	0.1	1
WC-C-75 (Check)	36	4.1	-
BJ 104 (Check)	66	14.0	44

a/ Based on number of infected heads and total heads/  
4 rows x 4 m plot/rep

b/ Based on 120 head observations in 3 replications

c/ Mean of 20 inoculated-bagged heads in the smut  
nursery Hissar, rainy season 1980

Table 14 Performance of nine ergot resistant F<sub>6</sub> lines under artificial inoculation conditions (Open-head inoculation) during the 1980-81 post rainy season at ICRISAT Center

Entry	Ergot reactions	
	Mean <sup>a</sup> / incidence (%)	Mean <sup>b</sup> / severity (%)
ICMPE 34-1-1	0	0
ICMPE 34-1-3	0.8	0.01
ICMPE 34-1-4	0.9	0.02
ICMPE 34-1-6	0.6	0.01
ICMPE 34-1-10	1.2	0.02
ICMPE 34-2-12	0.4	0.01
ICMPE 34-2-16	0	0
ICMPE 34-7-1	1.5	0.02
ICMPE 34-3-9 (BST)	1.2	0.05
BJ 104 (Check)	48	9.1
LSD (P=0.05)	6.05	4.04

a/ Based on number of infected heads and total heads/2 rows x 4m plot/rep

b/ Based on 80 head observations in 2 reps

Table 15. Ergot reactionf of 8 F7 bulk lines open inoculated during the 1980-81 post rainy season at ICPI SAT Center

Entry	Mean <sup>a/</sup> incidence (%)	Mean <sup>b/</sup> severity (%)
ICMPE 13-6-4	0.92	0.07
ICMPE 13-6-12	1.48	0.11
ICMPE 13-6-33	0.37	0.10
ICMPE 134-6-6	0.96	0.06
ICMPE 134-6-10	0.66	0.04
ICMPE 134-6-30	0.68	0.06
ICMPE 134-6-50	0.81	0.07
ICMPE 140-7-7	0.47	0.04
WC-C-75	37.03	9.35
BJ 104	54.13	23.10
LSD (P=0.05)	8.29	2.36

a/ Based on number of infected heads and total heads/4 rows x 4m plot/rep.

b/ Mean of 120 head obs. in 3 replications (4rows x 4m/rep.)

Table 16. Summary of ergot reactions of test crosses using ergot resistant (ER) F<sub>5</sub> lines, during the 1980 rainy season

MS lines	No. of F <sub>1</sub> hybrids	Mean <sup>a/</sup> ergot severity/range (%)		
		MS lines	ER F <sub>5</sub> lines <sup>b/</sup>	F <sub>1</sub> hybrids
111A	189	76	< 1-20	63-85
5054A	216	80	< 1-20	84-98
5141A	237	83	< 1-20	65-92

a/ Mean of 10-30 inoculated heads

b/ Ergot severity range of ER 30F<sub>5</sub> lines used in test crosses

Table 17. Ergot reactions of three synthetics, developed using 12 ergot resistant F<sub>5</sub> lines, during the 1980 rainy season

Synthetic	Ergot severity (%) <sup>a/</sup>	
	mean	range
ICMS 8031	12	5-30
ICMS 8032	15	5-40
ICMS 8034	14	5-35
WC-C-75	24	10-50
BJ 104	54	25-80

a/ Mean of 10-20 open-inoculated heads

Table 18. Summary of smut reactions<sup>a/</sup> of 396 entries in 12 ICARISAT Center operated breeding trials, screened at Mysur during the 1980 rainy season.

Trial	No. of entries	No. of entries in each smut severity class				
		0%	1-10%	11-20%	21-30%	>30%
PMHT	25	0	0	1	5	19
PMHT (P)	25	0	5	10	6	4
PMIHT-I	36	0	1	5	4	26
PMIHT-II	36	0	1	0	1	34
PMIHT-III	36	0	0	3	2	31
PMIHT-IV	36	0	1	1	6	28
ELVT	32	0	5	11	6	10
EVT	32	0	18	10	2	2
D <sub>2</sub> DVT	10	0	0	0	5	5
PMST	20	0	1	10	4	5
IPMAT-6	21	0	0	1	2	18
DONIAH	87	2	16	12	7	50
<b>Total</b>	<b>396</b>	<b>2</b>	<b>48</b>	<b>64</b>	<b>50</b>	<b>232</b>
<b>Percentage of entries</b>		<b>0.5</b>	<b>12.1</b>	<b>16.2</b>	<b>12.6</b>	<b>58.6</b>

a/ Mean of 10-20 inoculated inflorescences/entry



**Table 19.** Summary of smut reactions<sup>a/</sup> of 73 entries in four AICMIP trials, screened at Hisar during the 1980 rainy season

Trial	No. of entries	No. of entries in the smut severity class				
		<1%	1-10%	11-20%	21-30%	>30%
IPMHT-I	20	0	0	1	4	15
APMHT-II	25	0	0	2	6	17
IPMHT-IV	14	0	0	8	5	1
APMHT-V	14	0	0	7	2	5
<b>Total</b>	<b>73</b>	<b>0</b>	<b>0</b>	<b>18</b>	<b>17</b>	<b>38</b>
Percentage of entries		0	0	24.6	23.3	52.1

<sup>a/</sup> Mean of 20 inoculated-bagged inflorescences/entry

Table 20. Ergot, downy mildew (DM), and smut reactions, of the 32 entry 1980 IPMEN at ICRISAT Center

Entry	Ergot <sup>a/</sup> (%)	DM <sup>b/</sup> (%)	Smut <sup>c/</sup> (%)
ICMPE 140-3	<1	0	0
ICMPE 140-6	<1	0	<1
J 797-1-E-3-4	<1	9	4
SC-2(M)5-4-E-1-6	<1	37	2
700448-1-E-2-DM-3	<1	2	1
ICMPE 134-3	<1	3	2
ICMPE 134-5	<1	2	<1
ICMPE 140-1	<1	20	2
ICMPE 140-2	<1	0	0
ICMPE 140-7	<1	3	<1
ICMPE 143-3	<1	19	<1
ICMPE 143-4	<1	31	0
ICMPE 193-7	<1	0	1
ICMPE 192-9	<1	0	1
ICMPE 192-16	<1	0	2
ICMPE 13-2	<1	1	5
ICMPE 192-12	<1	0	5
ICMPE 13-4	<1	0	1
ICMPE 13-6	<1	1	1
ICMPE 192-2	<1	0	1
ND-2282-79-1-E-2-8-DM-1-1	<1	0	6
ICMPE 192-15	<1	0	1
ExBouchi 700638-3-2-E-1-DM-4	<1	8	3
ICMPE 192-5	<1	0	13
J 2238-2-E-4-1	1	0	2
700626-E-1-DM-1-3	1	2	9
ICMPE 134-6	1	1	1
700434-1-E-1-DM-1	2	0	6
700708-1-E-1-DM-1	2	11	1
700507-E-3-DM-1	2	0	0
700457-E-1-DM-4	3	1	<1
700489-1-E-1-DM-2	4	0	55
Local Resistant (700708-1-E-1)	<1	0	1
Susceptible (ICH-105)	29	-	60
BJ 104 (Trial Check)	36	54	51

a/ Mean of 40 inoculated-bagged heads from 2 replications

b/ Downy mildew incidence (%) at ICRISAT DM Nursery during the 1980 rainy season

c/ Smut (%) from smut nursery at Hissar during the 1980 rainy season.

Table 21. Summary of smut reactions<sup>a/</sup> of 261 entries in the Advanced Smut Screen at Hissar during the 1980 rainy season

Smut Severity (%) Class	No. of entries	Percentage of entries
0	28	10.8
0.1 to 1.0	75	28.7
1.1 to 5.0	61	23.4
5.1 to 10.0	25	9.6
10.1 to 20.0	39	15.0
>20	33	12.5

<sup>a/</sup> Based on mean smut reactions of 20 inoculated-bagged inflorescences per entry.

A total of 538 smut-free single heads were selected from 71 entries.

Table 22. Smut reactions and days to boot leaf stage (DTBL) of 38 entry Pearl Millet Smut Nursery (PMSN) during the 1980 rainy season at Hissar.

Sl No	Entry	DTBL	Smut severity %/ (x)	
			Mean	Range
1.	EB 137-2-S-7-1-DW-1*	49	0	0-0
2.	3/4 Ex Bornu 43-S-1-1-DW-1*	49	0	0-0
3.	ICI 7516-S-2-5*	55	0	0-0
4.	EB 209-1-6-S-4-1-DW-1*	51	<1	0-1
5.	MC FS 179-S-1-4-DW-1*	51	<1	0-1
6.	ICI 7516-S-2-7*	49	<1	0-1
7.	GAM 75 Bulk-S-1-3*	51	<1	0-1
8.	EB 237-3-4-S-1*	46	<1	0-1
9.	ND 2282-79-1-S-3-4*	51	<1	0-1
10	700544 x 700760-2-S-3-3*	65	<1	0-1
11	EB 66-1-S-3-3*	55	<1	0-1
12	WC FS 178-S-2*	49	<1	0-1
13	EB 137-1-1 S-1-1-DM-1*	51	<1	0-1
14	700713 x SC-2(N)3-7-4-2-S-3-3	49	<1	0-5
15	EB 137-1-2-S-3-2-DW-1*	49	<1	0-5
16	ND 2282-79-1-S-10-7	65	<1	0-5
17	ICI 7516-S-2-6*	51	<1	0-10
18	EB 209-1-6-S-7-DM-1*	49	<1	0-10
19	EBS 177-2-S-1-DW-1*	49	<1	0-10
20	EBS 119-2-1-S-4-2-DW-1	67	1	0-5
21	NEP 588-5690-S-8-5*	55	1	0-10
22	EB 132-2-S-4-4*	51	1	0-10
23	EBS 119-2-1-S-3-1-DW-1*	49	1	0-10
24	NEP 588-5690-S-8-3*	53	1	0-10
25	GAM 75 Bulk-S-3-1-DW-1*	46	1	0-10
26	EB 116-1-1-S-4-1-DW-1*	46	1	0-15
27	SDS FS 127-S-1-3	49	1	0-15
28	EB 137-1-1-S-6-2-DW-1	58	1	0-20
29	ND 2282-79-1-S-10-1-DW-1	49	2	0-10
30	J 2018-2-S-1	55	2	0-15
31	EB 7-2-3-S-4*	49	2	0-15
32	SC-2(N)12-12-S-3-3	49	2	0-20
33	WC FS 88-S-5-5	51	3	0-25
34	EB 117-2-1-S-2-3	55	3	0-30
35	EBS 32-3-S-1-1-DW-1*	49	4	0-75

SI No	Entry	DTBL	Smut severity <sup>a/</sup> (%)	
			Mean	Range
36	EB 7-2-3-S-1	59	5	0-40
37	EB 54-1-1-S-2-1-DW-1	53	6	1-35
38	EB 17-1-S-1-3	45	11	0-50
	BJ 104 Check	46	37	5-75

<sup>a/</sup> Mean of 20 inoculated-bagged heads in 2 replications

\* 270 Smut free single heads selected for further screening

Table 23. Mean snout severity (%)<sup>a/</sup> of the 32 1980 IPMSV entries and the local checks at seven locations with across location entry means<sup>b/</sup> and across entry locations means

Entry	LOCATION-							Overall Mean
	Bissar	ICRISAT	Jam- Nagar	Bamboy	Samaru	Kano	Sapu	
EB 117-4-3-S-2-2-DW-1	4	<1	1	2	1	8	6	3
SSC FS 252-S-4	0	0	0	0	4	3	19	4
EBS 137-2-S-1-DW-1	<1	<1	<1	<1	3	3	19	4
ICI 7517-S-1	0	0	0	1	10	8	8	4
NEP 588-5690-S-8-4	<1	<1	0	<1	8	12	8	4
EB 132-3-S-5-2-DW-1	<1	<1	<1	<1	15	7	8	4
EB 218-1-S-2	<1	1	0	1	12	7	4	4
EB 112-1-S-1-1	<1	0	0	<1	14	4	9	4
EB 237-2-S-3	3	<1	1	5	11	7	4	4
EB 15-1-S-3-1	1	<1	1	<1	19	3	7	4
700130-S-1-DW-1	<1	1	<1	1	8	13	3	4
SAR 466-S-1-DW-1	3	<1	2	<1	18	5	6	5
IP 2789-S-2	7	<1	3	2	10	7	4	5
EBS 46-1-2-S-2	<1	4	<1	1	21	5	9	6
EB-80-1-1-S-5	3	1	1	3	5	21	7	6
J 2222-S-1-3	10	<1	5	5	8	9	9	7
EBS 119-2-1-S-1-1	4	1	1	1	15	17	10	7
EB 24-1-S-5	1	1	8	2	14	15	6	7
WC FS 151-S-1-1	1	1	2	1	11	33	8	8
EB 209-1-6-S-7	8	2	5	6	18	12	5	8
EB 142-1-1-S-2-1	1	2	<1	6	18	30	7	9
J 1794-S-2-3	5	1	<1	1	38	11	12	10
EB 137-1-2-S-3	<1	1	0	1	41	25	11	11
J 797-1-S-3	<1	4	<1	4	20	43	7	11
WC FS 142-S-1-1	4	3	15	10	11	22	16	12
J 2226-S-1-1-DW-1	1	2	<1	1	27	49	7	12
EB 229-4-1-S-6-1	<1	3	<1	8	27	37	7	12
P-20-S-1	3	10	14	6	15	31	9	13
EBS 70-1-S-4-3	6	3	7	14	34	18	6	13
P-10-S-1	<1	10	1	3	39	27	16	14
EB 54-1-1-S-7-3	7	3	6	29	39	28	8	17
3/4 Ex Bornu 220-S-1-DW-1	23	38	15	40	29	44	4	28
Location means	3	3	3	5	17	18	8	8
Local Resistant	30	1	28	13	41	16	7	19
Local Susceptible	26	57	24	9	28	15	8	24
Trial Check (BJ 104)	30	61	31	31	68	72	7	42
(No. of entries mean $\pm$ 10%)	(31)	(31)	(30)	(29)	(9)	(13)	(26)	(22)

a/ Each datum is the mean of two rep. means and each rep. mean is derived from 20 inoculated-bagged heads except for Bamboy & Sapu where heads were just bagged.

b/ Mean for test entries

**Table 24** Summary of progress made in developing smut resistance from F<sub>1</sub> to F<sub>3</sub> generations

Smut severity (%) Class	Percentage of lines in each class at of testing		
	F <sub>1</sub>	F <sub>2</sub>	F <sub>3</sub>
0	7	5	30
0.1-1.0	82	47	37
1.1-5.0	11	28	17
5.1-10.0	0	13	10
10.1-20.0	0	5	5
>20	0	2	1

Number of lines/population at each generation:

F<sub>1</sub> = 117 lines, only 85 lines screened 10 plants/line during 1978 rainy season

F<sub>2</sub> = 117 populations, screened 20 plants/pop. during 1979 rainy season.

F<sub>3</sub> = 166 lines, screened 20 plants/line during 1980 rainy season

Table 25. Smut reactions and days to boot leaf stage (DTBL) of 40 P<sub>3</sub> lines (Smut low susc. x agro. elite) during the 1980 rainy season at Hissar

Sl No	Pedigree	DTBL	Smut severity (%)
1.	(ExB 132-2-S-75) x (70-1 x 700594-5-1-6)-3*	47	0
2.	(ExB 132-2-S-65) x (70-1 x 700594-5-1-6)-4*	50	0
3.	(ExB 132-2-S-75) x (70-1 x 700594-5-1-6)-5*	52	0
4.	(ExB 132-2-S-75) x (J25-1 x J1623-21-1)-4*	47	0
5.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-6*	72	0
6.	(ExB 237-3-1-S-76) x (B282 x J804-1-21-2)-4*	47	0
7.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-1*	58	0
8.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-2*	60	0
9.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-5*	58	0
10.	(ExB 237-3-1-S-76) x (J934-7 x 700797-19-1-5)-7*	51	0
11.	(ExB 132-2-S-75) x (70-1 x 700594-5-1-6)-2*	47	<1
12.	(ExB 132-2-S-75) x (J25-1 x 700797-1-5-2)-2*	53	<1
13.	(ExB 132-2-S-75) x (J25-1 x 700797-1-5-2)-3*	47	<1
14.	(ExB 132-2-S-75) x (J25-1 x 700797-1-5-2)-4*	50	<1
15.	(ExB 132-2-S-75) x (J25-1 x 700797-1-5-2)-5*	52	<1
16.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-4	71	<1
17.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-5	67	<1
18.	(ExB 237-3-1-S-76) x (B282 x J804-1-21-2)-1*	52	<1
19.	(ExB 237-3-1-S-76) x (B282 x J804-1-21-2)-2*	52	<1
20.	(ExB 237-3-1-S-76) x (J934-7 x 700797-19-1-5)-4*	50	<1
21.	(ExB 132-2-S-75) x (J25-1 x 700797-1-5-2)-1*	53	<1
22.	(ExB 237-3-1-S-76) x (J934 x 700797-19-1-5)-5*	50	<1
23.	(ExB 237-3-1-S-76) x (J934-7 x 700797-19-1-5)-6*	50	<1
24.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-6	59	<1
25.	(ExB 132-2-S-75) x (70-1 x 700594-5-1-6)-1	50	1
26.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-3	60	1
27.	(ExB 237-3-1-S-76) x (B282 x J 804-1-21-2)-3	55	1
28.	(ExB 132-2) x (J25-1 x J1623-21-1)-5	52	2
29.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-1	58	2
30.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-2	65	2
31.	(ExB 132-2-S-75) x (J25-1 x J 1623-21-1)-2	62	3
32.	(ExB 237-3-1-S-76) x (J 934-7 x 700797-19-1-5)-3	58	5
33.	(ExB 237-3-1-S-76) x (J104 x 700441-6-1)-7	55	6
34.	(ExB 132-2-S-75) x (J104 x 700441-6-1)-3	62	7
35.	(ExB 237-3-1-S-76) x (J934-7 x 700797-19-1-5)-2	62	8



Contd..

36	(ExB 132-2-S-75) x (J25-1 x J1623-21 P-1)-3	58	9
37	(ExB 237-3-1-S-76) x (B282 x J804-1-21-2)-5	47	10
38	(ExB 237-3-1-S-76) x (J104 x 700141-6-1)-4	58	13
39	(ExB 132-2-S-75) x (J25-1 x J1623-21 P-1)-1	47	16
40	(ExB 237-3-1-S-76) x (J934-7 x 700797-19-1-5)-1	58	25
	BJ 104 (Check)	46	44
	ICH 105 (Check)	48	60

a/ Mean of 20 inoculated-bagged heads

\* 158 Smut free single heads selected for evaluation at F<sub>4</sub>

Table 26. Smut reactions and days to boot leaf stage (DTBL) of 14 F<sub>2</sub> populations (EC 298-3 x SR) and 5 smut resistant parents during the 1980 rainy season at Kassar

Sl No	Pedigree	DTBL	Smut severity <sup>a/</sup> (%) Mean	No. of heads selected
1.	EC 298-3 x EB 132-2-2-5-8-S-9 P-D-1	58	<1	6
2.	EC 298-3-x WC FS 148-S-1 S-27, PH-2	52	<1	10
3.	EC 298-3 x EB 132-2-2-5-8-S-9 P-D-2	56	1	9
4.	EC 298-3 x P-10-S-1 S-32, PF-1	52	1	11
5.	EC 298-3 x 700130-S-1 P-1 (S-3)-3	52	1	12
6.	EC 298-3 x 700130-S-1 P-1 (S-3)-2	52	2	14
7.	EC 298-S x 700130-S-1 P-1 (S-3)-1	52	2	6
8.	EC 298-3 x EB 116-1-1-5-7 S-23-P-1-3	56	5	-
9.	EC 298-3 x EB 116-1-1-5-7 S-23-P-1-1	58	6	7
10.	EC 298-3 x P-10-S-1 S-32,PF-2	52	7	6
11.	EC 298-3 x EB 24-1-S-5 S-24, PA-2	52	10	-
12.	EC 298-3 x EB 24-1-S-5 S-24, PA-1	56	11	-
13.	EC 298-3 x WCFS 148-S-1 S-27 PH-1	52	13	-
14.	EC 298-3 x EB 116-1-1-S 7 S-23-P-1-2	58	18	-
	BJ 104 Check	46	44	-
<u>Parents</u>				
	700130-S-1 IPMSN-S <sub>3</sub> P-1-1-1	55	1	4
	WC FS 148-S-1 S-27 PH-2	63	1	4
	EB 24-1-S-5-S-24 PA-1	52	.1	5
	WC FS 148-S-1 S-27 PH-1	58	2	10
	EB 116-1-1-S-7 S-23-1	58	5	6

a/ mean of 20 inoculated-bagged heads

- selections not made

Table 27. Smut reactions and days to boot leaf stage (DTBL) of 8 F<sub>2</sub> (23D<sub>2</sub>B x SR) populations during 1980 rainy season at Hissar

Sl No	CROSS	DTBL	Smut severity		No. of heads selected
			Mean*	Range	
1.	23D <sub>2</sub> B x WCFS-148 P <sub>4</sub>	54	3	1-25	4
2.	23D <sub>2</sub> B (I) x EB 74-3 P <sub>8</sub>	48	3	0-15	5
3.	23D <sub>2</sub> B (I) x EB 74-3 P <sub>3</sub>	56	4	0-50	23
4.	23D <sub>2</sub> B x EB 24-1 P <sub>4</sub>	50	9	0-45	8
5.	23D <sub>2</sub> B (I) x SSC FS 252 P <sub>1</sub>	52	12	0-75	13
6.	23D <sub>2</sub> B (I) x EB 137-1-1-P <sub>14</sub>	51	14	0-60	5
7.	23D <sub>2</sub> B (I) x EB 137-1-1-P <sub>2</sub>	49	15	0-85	7
8.	23D <sub>2</sub> B x EB 137-1-1-P <sub>8</sub>	49	18	0-90	8
	BJ 104 (Check)	46	44	20-70	

\* Mean of 20-100 inoculated-bagged heads from dwarf plants.

Table 28. Smut reactions and days to boot leaf stage (17° L) of Test Cross Nursery, Parents and male sterile lines during the 1986 Kharif season at Hisar.

Sl No	Cross/Parent lines	DTB1	Smut severity (%)	
			mean <sup>A</sup>	Range
1	5054A x ICI 7517-S-1-P <sub>1</sub>	47	1	0-5
2	5054A x NEP 588-5690-S-8-4-P <sub>3</sub>	47	2	0-5
3	111A x NEP 588-5690-S-8-4-P <sub>1</sub>	58	2	1-5
4	111A x NEP 588-5690-S-8-4-P <sub>3</sub>	58	3	1-10
5	5054A x ICI 7517-S-1-P <sub>2</sub>	47	3	1-10
6	5054A x P-10-S-1-P <sub>2</sub>	45	4	1-15
7	5141A x SSC FS 252-S-4-P <sub>1</sub>	53	5	0-10
8	5054A x NEP 588-5690-S-8-4-P <sub>2</sub>	50	5	1-15
9	5054A x J 797-1-S-3-P <sub>3</sub>	47	5	1-35
10	5054A x SSC FS 252-S-4-P <sub>3</sub>	47	6	2-15
11	5141A x J797-1-S-3-P	47	7	1-20
12	5054A x NEP-588-5690-S-8-4-P <sub>1</sub>	47	7	1-25
13	111A x NEP 588-5690-S-8-4-P <sub>2</sub>	55	8	1-45
14	5141A x ICI 7517-S-1-P <sub>2</sub>	50	11	1-20
15	5054A x SSC FS 252-S-4-P <sub>1</sub>	47	11	1-30
16	5054A x EB 218-1-S-2-P <sub>2</sub>	50	12	2-35
17	5054A x SSC FS 252-S-4-P <sub>2</sub>	47	13	2-25
18	5141A x NEP 588-5690-S-8-4-P <sub>1</sub>	50	13	2-25
19	5054A x EB 137-2-S-1-(DM-1)P <sub>1</sub>	47	14	5-35
20	5054A x J-2222-S-1-3-P <sub>3</sub>	47	14	2-60
21	5141A x P-10-S-1-P <sub>2</sub>	47	14	2-60
22	5141A x ICI 7517-S-1-P <sub>1</sub>	50	15	10-30
23	5054A x EB218-1-S-2-P <sub>1</sub>	50	15	5-25
24	5054A x J2222-S-1-3-P <sub>2</sub>	47	15	2-45
25	5141A x EB 218-1-S-2-P <sub>2</sub>	53	16	2-35
26	5054A x EB137-1-1-S-8-P <sub>1</sub>	47	16	1-70
27	111A x MCFS 171-S-1-3-P <sub>2</sub>	53	18	5-40
28	5141A x SSC FS 252-S-4-P <sub>2</sub>	53	18	1-80
29	5054A x EB 218-1-S-2-P <sub>3</sub>	50	21	10-35
30	5054A x MCFS 171-S-1-3-P <sub>2</sub>	50	21	10-35
31	111A x EB 137-1-1-S-8-P <sub>2</sub>	55	22	5-45
32	111A x MC FS 171-S-1-3-P <sub>3</sub>	55	22	5-45
33	5141A x EB 218-1-S-2-P <sub>1</sub>	52	22	5-60
34	5141A x NEP 588-5690-S-8-4-P <sub>3</sub>	50	23	10-45
35	5054A x J2222-S-1-3-P <sub>1</sub>	47	23	5-70

contd.

SI	NO	Cross/Pedigree	DTRL Smut severity (%)	Mean <sup>d</sup> / Rang
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36	111A x EB 218-1-S-2-P <sub>3</sub>	50	24	2-4
37	111A x J2222-S-1-3-P <sub>3</sub>	58	25	10-6
38	5141A x EB 218-1-S-2-P <sub>3</sub>	57	25	5-6
39	5054A x MC FS 171-S-1-1-P <sub>3</sub>	50	26	2-0
40	5141A x NRP 588-5690-S-8-4-P <sub>2</sub>	50	27	15-40
41	111A x J2222-S-1-3-P <sub>2</sub>	58	27	5-60
42	111A x J2222-S-1-3-P <sub>1</sub>	58	29	10-60
43	5141A x SSC FS 252-S-4-P <sub>3</sub>	47	29	10-60
44	5141A x MC FS 171-S-1-3-P <sub>3</sub>	55	32	5-70
45	111A x SSC FS 252-S-4-P <sub>2</sub>	50	35	15-60
46	111A x P-10-S-1-P <sub>1</sub>	50	40	15-70
47	5141A x J-2222-S-1-P <sub>3</sub>	53	43	15-80
48	111A x EB 137-1-1-S-8-P <sub>1</sub>	55	45	1-75
49	5054A x P-10-S-1-P <sub>3</sub>	47	46	2-98
50	5054A x P-10-S-1-P <sub>1</sub>	47	47	5-80
51	5141A x EB 137-1-1-S-8-P <sub>3</sub>	47	51	10-98
52	111A x EB 137-2-S-1(DM-1)P <sub>1</sub>	50	52	10-90
53	5141A x EB 137-2-S-1(DM-1)-P <sub>2</sub>	50	56	20-85
54	5141A x MC FS 171-S-1-3-P <sub>2</sub>	50	57	35-80
55	5141A x EB 137-1-1-S-8-P <sub>2</sub>	52	60	35-95
56	5141A x EB 137-1-1-S-8-P <sub>1</sub>	52	63	15-98
57	5141A x EB 137-2-S-1(DM-1)P <sub>3</sub>	52	66	5-95
58	5141A x P-10-S-1-P <sub>1</sub>	50	75	5-98
59	5141A x EB 137-2-S-1(DM-1)P <sub>3</sub>	50	78	60-90
60	5141A x P-10-S-1-P <sub>3</sub>	50	78	15-100
<u>Parents</u>				
1	SSC FS 252-S-4P <sub>1</sub>	62	0	0-0
2	SSC FS 252-S-4-P <sub>2</sub>	72	0	0-0
3	SSC FS 252-S-4-P <sub>3</sub>	65	0	0-0
4	ICI 7517-S-1-P <sub>1</sub>	65	0	0-0
5	ICI 7517-S-1-P <sub>2</sub>	72	0	0-0
6	J 797-1-S-3-P <sub>3</sub>	50	0	0-0
7	EB 218-1-S-2-P <sub>3</sub>	58	0	0-0
8	MC FS 171-S-1-3-P <sub>2</sub>	58	0	0-0
9	MC FS 171-S-1-3-P <sub>3</sub>	58	0	0-0
10	NRP 588-5690-S-8-4-P <sub>1</sub>	62	0	0-0

Contd..

Sl No	Cross/Pedigree	DTBL	Smut severity (%)	
			Mean <sup>a/</sup>	Range
11	NEP 588-5690-S-8-4-P <sub>2</sub>	58	0	0-0
12	NEP 588-5690-S-8-4-P <sub>3</sub>	60	0	0-0
13	EB 137-1-1-S-8-P <sub>2</sub>	72	1	0-1
14	EB 218-1-S-2-P <sub>2</sub>	58	1	0-1
15	J 2222-S-1-3-P <sub>3</sub>	61	1	1-2
16	J 2222-S-1-3-P <sub>1</sub>	65	2	1-5
17	P-10-S-1-P <sub>3</sub>	55	4	1-15
18	P-10-S-1-P <sub>2</sub>	52	5	1-25
19	EB 137-2-S-1 (DN-1)-P <sub>1</sub>	50	6	1-20
20	EB 137-1-1-S-8-P <sub>3</sub>	65	8	1-20
21	P-10-S-1-P <sub>1</sub>	55	8	1-35
22	EB 137-1-1-S-8-P <sub>1</sub>	55	13	1-35
23	EB 137-2-S-1 (DN-1)-P <sub>3</sub>	55	15	2-40
24	EB 137-2-S-1 (DN-1)-P <sub>2</sub>	61	16	5-45
25	J 2222-S-1-3-P <sub>2</sub>	57	18	0-45

Male Sterile lines

1	5054A	50	47	30-70
2	111A	58	53	10-90
3	23D <sub>2</sub> A	58	63	35-100
4	5141A	62	70	60-80
5	5141B	47	37	15-60
6	5054B	64	82	60-98
7	111B	50	86	70-90

<sup>a/</sup> Mean of 10 inoculated-bagged heads and each datum is rounded off to the nearest whole number.

Table 29. Summary of smut reactions<sup>a/</sup> of smut resistant composite (SRC) progenies screened during the 1980 rainy season at Hissar

Composite	No. of progenies	No. of progenies in smut severity class			
		0-<1	1-10	11-20	>20
SRC I	307	34	216	50	7
SRC II	255	12	179	45	19
Total	562	46	395	95	26
Percentage of lines		8.2	70.3	16.9	4.6

<sup>a/</sup> Based on mean of 10 inoculated-bagged inflorescences