NUCLEAR POLYHEDROSIS VIRUS OF
AGROTM IPSILON (HUFNAGEL)
(NOCTUIDAE: LEPIDOPTERA), THE BLACK
CUTWORM OF CABBAGE

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THE black cutworm, Agrotis ipsilon is a serious pest
having wide geographical distribution and infesting
a variety of crop plants causing severe economic losses
in many parts of the world. During field surveys in
Tamil Nadu for pathogenic micro-organisms asso-
ciated with crop pests which could be used as bio-
control agents in the integrated pest management
system, the larvae of A. ipsilon infesting cabbage in the
Nilgiris (Tamil Nadu) had shown the virosis symp-
toms. The dead cadavers were brought to the labora-
tory and the presence of inclusion bodies was con-

The virus from the dead cadavers was extracted and
purified. The pathogenicity of the virus was assessed
in the laboratory by feeding healthy, laboratory reared
larvae of A. ipsilon with cabbage leaf discs con-
taminated with the viral suspension. The larvae fed for
two days and thereafter either ceased to feed or
showed diminished feeding rate. The larvae then
became sluggish, with flaccid body, changed to pale
white in colour and died within 120 hr after ingestion
of virus contaminated food. Some of them also
showed the typical wipfelkrankheit symptom of viral
infection (figure 1). The body wall finally ruptured

and white liquefied body contents oozed out. The
smear prepared with oozing body fluid was stained
with azocarmine G and the inclusion body of NPV
took brilliant red colour confirming the presence of
inclusion body virus. Even though nuclear poly-
heedrosis of A. ipsilon has been reported from China,
this is the first report from India.

Further studies on the utility of this virus for the
control of A. ipsilon in the field are in progress.

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2. Palmieri, J. R., Kelderman, W. and Sullivan, J. T.,
3. Tsai, S. Y., Hwang, G. H. and Ding, T., Acta

GENETIC MARKERS TO DETECT APOMIXIS
IN SORGHUM BICOLOR L. MOENCH

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FACULTATIVE apomixis resulting from apospory, diplo-
spory and synkaryogenesis occurs in sorghum, Sorghum bicolor (L.) Moench. The existence of
these 3 mechanisms was mostly established from
embryological studies. Occurrence of apospory and
diplospory could also be established through progeny
tests using quantitative characters like number of days
taken for flowering, compactness of the panicle, awn
length and plant height. In all these studies, apomixis was difficult to estimate because of the lack of
simple genetic markers and the presence of an interfering cross-sterility. In the present study, 2 simple
genetic markers tan plant colour and shrivelled seed,
were used to detect and estimate apomixis. These two
characters are known to be governed by a single
recessive gene.

SPV-232, a tan (pp) sorghum line was crossed to R
473, a purple (PP) coloured facultative apomict. The
F₁ was purple (Pp) and the F₂ segregated into tan and
purple plants in 3:1 ratio. Individual tan plants from
F₂ were screened for the presence of apomixis through
ovule squashes and cross-sterility. Out of 124 F₂
individuals, 19 were cross-sterile. Of these, 5 plants
were tan. Three of them (8, 53 and 122) were apomicts.

Figure 1. Infected (D) and healthy (H) larva of
A. ipsilon
Figure 1. Frequency distribution of plants with varying degrees of apomixis in the different crosses and generations.

These plants were crossed as females to R 473. The resulting progeny was either completely tan (12 out of 12 in the case of 8 × R 473 and 6 out of 6 in the case of 53) or a mixture of tan and purple (7 out of 8 in the case of 122 × R 473). The tan plants could have arisen only through apomixis. Accidental selfing was ruled out since in none of the controls (crosses of tan sexual × R 473), tan plants could be recovered.

In another study three high lysine shrivelled (su su) endosperm sorghum lines N 82, N 93, and N 94 were crossed as females to R 473 (Su Su). F₂, F₃ and BC₁F₁ progenies were built up. Seeds with the genotype (su su) will be shrivelled. The F₀ (crossed) seed was plump. The seed on the F₁ plant itself segregated into shrivelled and plump. The segregation of shrivelled and plump seeds was tested using chi-square values in the F₂ (on the F₁ plant), F₃ (on the F₂ plant) and in the BC₁F₁ generations during the rabi and/or kharif season. A sexual cross P 721 (plump) × N 84 was used as a control. Normal 3:1 segregation occurred in this cross. However, in the sexual × facultative apomictic crosses significant deviations occurred indicating the occurrence of apomixis. The frequency x of apomixis was calculated as

\[ x = 1 - 4y \]

where y is the frequency of observed shrivelled seed.

The mean frequency of apomixis in the various generations and occurrence of plants with a high frequency (50%) of apomixis are given in table 1. The more or less continuous distribution of apomictic plants shows that it is under complex genetic control.

The present study shows that either of these two

<table>
<thead>
<tr>
<th>No.</th>
<th>Cross</th>
<th>Generation</th>
<th>Season</th>
<th>Shrivelled</th>
<th>Plump</th>
<th>Apomixis frequency</th>
<th>No. of plants with more than 50% apomixis</th>
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<tbody>
<tr>
<td>1.</td>
<td>N 82 × R 473</td>
<td>F₂</td>
<td>Rabi</td>
<td>331</td>
<td>1161</td>
<td>0–90</td>
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<td></td>
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<td>Kharif</td>
<td>4790</td>
<td>18060</td>
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<td></td>
<td>F₃</td>
<td>Rabi</td>
<td>3584</td>
<td>10291</td>
<td>0–75</td>
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<td>Kharif</td>
<td>2171</td>
<td>8529</td>
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<td>18.84</td>
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<td>F₂</td>
<td>Rabi</td>
<td>753</td>
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<td></td>
<td>F₃</td>
<td>Rabi</td>
<td>3352</td>
<td>14889</td>
<td>0–45</td>
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<td>Kharif</td>
<td>2455</td>
<td>6227</td>
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<td>19.35</td>
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<td></td>
<td>BC₁F₁</td>
<td>Kharif</td>
<td>3493</td>
<td>13832</td>
<td>0–50</td>
<td>19.35</td>
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<tr>
<td>2.</td>
<td>N 93 × R 473</td>
<td>F₂</td>
<td>Rabi</td>
<td>39</td>
<td>142</td>
<td>0–40</td>
<td>5.78</td>
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<td></td>
<td></td>
<td>Kharif</td>
<td>2654</td>
<td>8614</td>
<td>0–80</td>
<td>28.59</td>
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<td></td>
<td></td>
<td>F₃</td>
<td>Rabi</td>
<td>4</td>
<td>112</td>
<td>~</td>
<td>86.2</td>
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<td>Kharif</td>
<td>1858</td>
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<td>BC₁F₁</td>
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<td>7329</td>
<td>0–50</td>
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<tr>
<td>3.</td>
<td>N 94 × R 473</td>
<td>F₂</td>
<td>Rabi</td>
<td>39</td>
<td>142</td>
<td>0–40</td>
<td>5.78</td>
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<tr>
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<td>Kharif</td>
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<td>0–50</td>
<td>36.04</td>
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<td>4.</td>
<td>Control:</td>
<td>P 721 × N 94</td>
<td>Kharif</td>
<td>2129</td>
<td>6624</td>
<td>0–80</td>
<td>36.04</td>
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* Grand mean became negative because of greater frequency of shrivelled grains.
characters can be used to detect and estimate apomixis. But both characters have their own advantages and disadvantages. With the tan plant character, one has to grow the plants for making a progeny test. In the case of shrivelled-seed character, apomixis frequency can be estimated from the crossed seed itself. However, shrivelled seeded lines are useless as breeding lines, while tan plants lines are much more desirable than purple plants. Further, earhead diseases result in improperly filled grains simulating the shrivelled character. It is therefore suggested that tan plant character is used in estimations of apomixis in breeding experiments and the shrivelled grain character in quick estimations in basic studies aimed at achieving obligate apomixis.

The authors are thankful to Drs N. G. P. Rao and V. Jaya Mohan Rao for supplying the seed of N 82, N 93 and N 94. This investigation forms part of a National Project supported by the Indian Council of Agricultural Research. The authors are thankful to Dr H. K. Jain for his interest in this work.

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A SPONTANEOUS MUTANT WITH THREE-STYLE PISTILS IN *Avena sativa* L.

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The grasses are characterized with pistil consisting of a one-loculate ovary having a single ovule and usually two styles bearing feathery stigmas. Robbins pointed out that in all grasses the pistil contains three fibrovascular bundles, with two extending into styrar branches and the third continuing into either the dorsal lobe or a stylar branch. In the genus *Avena*, the ovary invariably at its apex, bears two whitish feathery stigmas on very short styles (figure 1).

While emasculating the florets of various *Avena sativa* L. genotypes raised in the 1981–1982 crossing block at this Institute, the florets of one plant of the strain 'OS-8' were found to possess three styles. The progeny of this plant was raised during *rabi* 1982–'83 along with normal parental line. No differences in the morphological plant attributes and flowering time were found. However, all the plants in the progeny of the mutant were found to possess three styles and stigmas in many florets (figure 2). Cytological observations on pollen mother cells of these plants exhibited normal meiosis with 21 bivalents at metaphase I.

It was found that 111 out of the 316 mature florets from 17 panicles taken at random possessed three styles. Since all the plants in the progeny were characterised by the presence of such florets, the penetrance of the three-style pistil character appeared to be complete. However, the expressivity of this trait varied from 12.5–60% with an average value of

**Figures 1 & 2.** 1. Pistil of normal *A. sativa* with two styles. 2. Pistil of the spontaneous mutant with three styles.