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Field Evaluation of Sunflower Varieties for Susceptibility to the Parthenium Beetle *Zygogramma bicolorata*

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ABSTRACT

Fifteen varieties of sunflower (*Helianthus annuus* L.) were evaluated under field conditions for their feeding attraction to the Mexican beetle *Zygogramma bicolorata* Pallister (Coleoptera ; Chrysomelidae), a potential biological control agent of the noxious weed *Parthenium hysterophorus* L. (Asteraceae). When 500 marked adults were released on one-month-old sunflower plants, 90% of them were observed to move away in one day, 99.2% by the 4th day and 100% by the 7th day. Although upto 4.81 million adults were estimated to be present at a time in the 2 ha weed stand surrounding the experimental plot, the numbers that alighted on the sunflower crop were negligible and did not exceed 316 adults on 651 plants. However, slight feeding by adults was noticed on 6 plants for 5 days, after which they moved away. The present studies indicate that sunflower is not a suitable host plant for the beetle and the chances of host shift appear remote.

KEY WORDS: *Zygogramma bicolorata, Parthenium hysterophorus*, susceptibility, sunflower, varieties

Zygogramma bicolorata Pallister (Coleoptera : Chrysomelidae) of Mexican origin, was released in Bangalore in 1984 for biological control trials against the noxious alien weed *Parthenium hysterophorus* L. (Asteraceae). The insect, which established readily (Jayanth, 1987) started building up damaging population levels from 1988. It has now spread over 50,000 sq km area in Karnataka, Tamil Nadu and Andhra Pradesh, causing large scale defoliation of the weed. This in turn has affected the flower production capacity of the weed and has encouraged the growth of local vegetation earlier suppressed by parthenium (Jayanth, 1991).

Detailed host-specificity tests carried out in Mexico, Australia and India (McFadyen and McClay, 1981; Jayanth and Nagarkatti, 1987) had confirmed the safety of *Z. bicolorata* to cultivated plants. During these studies, the insect was only found to nibble but not feed on sunflower (*Helianthus annuus* L.). However, the insect was reported to feed on sunflower in Kolar district in Karnataka (Kumar, 1992). The present studies were therefore carried out to determine the safety of this insect to some of the local commercial varieties of sunflower (including Morden, which was used for the tests carried out in India in 1983) and parental lines of the crop.

MATERIALS AND METHODS

Thirteen popular sunflower varieties (BSH-1, EC-68415, EPRO-1, IAHS-1, KBSH-1, LDMRSH-1, Morden, MSFH-1, MSFH-8, MSFH-17, PAC- 3425, Sunbred-212 and Sunbred-265) and two parental lines (CMS-234B and RHA-274) were raised in the experimental farm of the Indian Institute of Horticultural Research at Hessaraghatta in Bangalore during the last week of June 1992. Each variety was sown in 2 rows of 10 m length with a spacing of 40 cm (about 25 plants/row) and normal agricultural operations, excluding insecticidal sprays, were undertaken. The sunflower plot was located in the middle of a parthenium-infested field, spread over more than 2 ha area. Care was also taken not to weed out parthenium plants growing in the sunflower plot.

On 28th July 1992, five hundred field-collected adults of *Z. bicolorata* that were marked

Table 1. Daily count of marked adults of *Z.bicolorata* on different sunflower varieties

Variety	29/7/92	30/7	31/7	1/8	2/8	3/8
BSH - 1	0	0	0	0	0	0
CMS - 234 B	0	0	0	0	0	0
EC - 68415	1	0	0	0	0	0
EPRO - 1	9	6	2	0	0	0
IAHS - 1	2	1	1	0	0	0
KBSH - 1	3	3	0	0	0	0
LDMRSH - 1	0	0	0	0	0	0
Morden	1	2	1	0	0	0
MSFH - 1	3	4	1	0	0	0
MSFH - 8	2	1	0	0	0	0
MSFH - 17	10	3	0	0	0	0
PAC - 3425	6	6	2	1	0	0
RHA - 274	0	0	0	0	0	0
Sunbred - 212	5	3	2	2	1	1
Sunbred - 265	3	1	0	1	1	1
Total	44	30	9	4	2	2

on the elytra with stencil correcting fluid (Mfd. Kores (India) Ltd., Bombay), were released on the one month old sunflower plants, at the rate of 5 adults per plant on 3-4 randomly - selected plants per row, depending on the plant population. Adults were released on at least 6 plants per variety. Stencil correcting fluid, which leaves a bright pink mark, was found superior to nail polish for marking the adults as it dried instantly without smudging. Pilot studies had also shown that the markings did not peel off nor fade for at least 10 days. Marking of adults was resorted to, as beetles from adjoining parthenium stand were noticed to alight on the crop. From the first day after release, all sunflower plants in the experimental plot were examined daily and the total number of marked adults on each variety were recorded.

Observations were also recorded on the presence of unmarked adults of the beetle on sunflower. For this, weekly counts were made of the total number of adults present on all the sunflower plants in the experimental plot, from the first week after germination, for a period of 10 weeks. Simultaneously, the population build up of *Z. bicolorata* on parthenium plants growing around the sunflower field was also monitored at weekly intervals. These observations were made on 25 randomly-selected plants. Visual observations were made on defoliation of the weed. Estimates were also made of the weed density and the total adult population in the 2 ha parthenium stand.

RESULTS AND DISCUSSION

The results of the studies involving release of marked adults of *Z. bicolorata* on 15 different varieties of sunflower are presented in Table 1. It was observed that 91.2% of the 500 released adults moved away within one day. Only 0.8% of them remained on the crop by the 4th day, 0.4% by the 5th and none by the 7th.

None of the released adults could be recovered on BSH-1, LDMRSH-1, CMS-234 B and RHA-274 on the first day after release, while the maximum numbers (5-10 adults/variety) were noticed on MSFH-17, EPRO-1 and PAC-3425. However, no feeding was observed on any of the varieties and the population of released adults declined over the next 2 days. The marked adults remained for a maximum duration of 6 days on Sunbred-212 and Sunbred-265, while they were noticed for 4 days on PAC-3425.

Table 2. Population of unmarked *Z. bicolorata* adults on sunflower and parthenium in the experimental plot at Hessaraghatta

Week	Date of observation	Adults/plant		Estimated adults on parthenium in 2 ha area (millions)
		Sunflower	Parthenium	
1	30/6/92	0.00	1.45	0.97
2	6/7/92	0.00	2.60	1.74
3	14/7/92	0.00	4.32	2.89
4	21/7/92	0.01	7.20	4.81
5	29/7/92	0.04	5.56	3.71
6	5/8/92	0.31	3.15	2.10
7	12/8/82	0.48	2.06	1.38
8	17/8/92	0.30	1.80	1.20
9	24/8/92	0.11	1.20	0.80
10	1/9/92	0.00	0.40	0.27

Adults of the bettle were not seen to migrate from the parthenium plants as long as parthenium leaves were available for feeding. This was indicated by the absence of the beetle on the crop during the first three weeks of its growth, as parthenium plants had not been defoliated. During this period (30 June - 14 July) 1.45 - 4.32 adults per plant could be observed on the weed stand surrounding the sunflower plot and an estimated 0.97-2.87 million adults were present on the 2 ha parthenium infestation (Table 2). About 30-40 parthenium plants were found to be present per m^2 and the estimation was made based on the mean value (33.4 plants/m^2).

As the weed started getting defoliated, a few stray adults were seen to alight on the sunflower plants during the 4th and 5th weeks, increased over the next 3 weeks and then declined (Table 3). The numbers that alighted on sunflower were negligible considering the fact that a peak population of about 3.71-4.81 million adults were estimated to be present in the vicinity (Table 2) and also that they had started migrating after defoliating the weed. Adults could be observed to fly in large numbers and alight on other crop plants and weeds also. The crops on which adults were collected included mango, guava, ber, fig, jasmine, patcholi and China aster. Adults of the beetle were also collected on the following weeds, *viz., Acanthospermum hispidum, Amaranthus spinosus, Cynodon dactylon, Euphorbia geniculata, E. hirta* and *Lagasca mollis*. Among these, slight feeding was noticed on *A. hispidum* and *L. mollis*, during the same period when feeding was noticed on sunflower. But only insignificant damage was found to be caused to the leaves of the above weeds.

A slight increase in the number of adults present on sunflower was noticed soon after about 5000 m^2 parthenium infested area, adjacent to the experimental plot was ploughed during the first week of August (6th week of the study period) (Table 2). The maximum number of adults present on sunflower plants was found to increase to 316 on 651 plants during the 7th week (Table 3). During this period slight feeding was noticed on 6 of the plants belonging to the varieties Sunbred-265 (2), MSFH-8 (2), EPRO-1 (1) and IAHS-1 (1). The adults were seen to feed on the margins of the top 3-4 leaves and about 5-10% of the surface area was consumed in 5 days, as estimated by visual observation, after which they moved away. Feeding was not noticed on most of the plants, even when adults were present.

Thus no feeding was noticed on an EPRO-1 plant on which 11 adults were noticed to be present, although feeding was noticed on another plant of the same variety. Upto 5 eggs were noticed to have been laid on 10-15% of all

Table 3. Distribution of unmarked *Z. bicolorata* adults on different sunflower varieties between 4-9 weeks of the observation period

Variety	No. of plants	No. of adults observed					
		Weeks					
		4	5	6	7	8	9
BSH - 1	40	0	0	1	8	5	2
CMS - 234 B	51	0	0	32	15	9	18
EC - 68415	23	0	0	1	2	6	8
EPRO - 1	51	1	2	40	78	42	7
IAHS - 1	49	0	0	12	22	16	1
KBSH - 1	39	1	3	10	9	15	5
LDMRSH - 1	40	0	1	2	10	0	0
Morden	45	1	4	8	23	18	5
MSFH - 1	33	4	7	1	14	5	5
MSFH - 8	54	0	0	4	12	17	2
MSFH - 17	50	0	0	38	50	27	10
PAC - 3425	48	1	2	5	13	7	3
RHA - 274	27	1	4	4	8	8	1
Sunbred - 212	52	0	1	3	12	13	3
Sunbred - 265	49	0	1	41	40	37	3
Total	651	9	25	202	316	225	73

varieties. However, no preference could be discerned for oviposition towards any particular variety. The few eggs that were laid were noticed to hatch, but the larvae failed to feed or develop.

It is clear from the present studies that *Z. bicolorata* is not attracted to sunflower and that its presence is due to chance alighting. The slight feeding noticed on sunflower could be due to over population and starvation following sudden destruction of the weed. Such reports of local and temporary damage to non-host plants are available in the literature, such as feeding by *Teleonemia scrupulosa* Stal on *Sesamum indicum* in Uganda (Greathead, 1971) and *Cactoblastis cactorum* (Bergroth) on tomato in Australia (Williams, 1954).

Host transference has not occurred so far among insects used for biological control of weeds. Host transference involves acquisition by the insect of the ability to survive on a new host (Zwolfer and Harris, 1971). Specificity is controlled by a series of stimuli originating from the host plant. The insects respond to these stimuli through various types of sensory structures that have co- evolved in the long association and constant interaction between the insects, the host plant and its habitat (Sankaran, 1990). Since *P. hysterophorus*, *Z. bicolorata* and *H. annuus* have all originated in the Neotropics and since the insect has not switched host in its native home, the chances of *Z. bicolorata* becoming a pest of sunflower appears to be very remote. However, further studies are required to find out the reasons for the aberrant feeding behaviour of the insect.

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