Table 2. Effect of green manure incorporation on *rabi* rice

| Treatments | Plant height (cm) | Effective tillers (No). | Grain number panicle | 1000 grain weight (g) | Grain yield (q/ha) | Straw yield (q/ha) |
|---|---|---|---|---|---|---|
| Control | 71.8 | 9.7 | 101.6 | 21.90 | 41.6 | 75.4 |
| *Sesbania rostrata* | 81.4 | 11.9 | 116.2 | 22.04 | 45.5 | 82.4 |
| *S.aculeata* | 74.6 | 10.3 | 105.6 | 21.96 | 43.3 | 78.2 |
| *S.speciosa* | 81.8 | 11.5 | 114.8 | 22.06 | 45.2 | 81.3 |
| CD (P=0.05) | 4.1 | 1.6 | 14.3 | N.S. | 3.6 | 6.3 |

yields. This indicated that the growth and yield of *kharif* rice was not affected by intercropping of GM in rogue space.

**Effect of intercropping on *rabi* rice**

It was observed that the growth and yield components such as plant height, effective tillers and number of grains per panicle were significantly influenced by incorporation of *S. rostrata*, which was closely followed by *S. speciosa* (Table 2). However, there was no significant effect on 1000 grain weight due to incorporation of GM crops. The efficient utilisation of mineralised N from the incorporated *S. rostrata* and *S. speciosa* along with applied fertilizer nitrogen would have increased the availability of N throughout the growth period increasing the growth and yield attributes in *rabi* rice.

Incorporation of GM exhibited a profound effect on grain and straw yield over control. Among the treatments, incorporation of *S. rostrata* recorded significantly increased grain (45.5 q/ha) and straw (82.4 q/ha) yield which was 9.4 and 9.3 per cent higher than control respectively. The grain and straw yields obtained with *S. rostrata* incorporation were comparable with that of *S. speciosa* incorporation. The yield increase in *rabi* rice was attributed to better growth and yield components under GM incorporation with recommended level of inorganic fertilizers. Similar yield increase in rice due to combined application of inorganic fertilizer and GM has been reported by Meelu and Rekhi (1981) and Jayaraman (1991).

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# EVALUATION OF ELITE SAFFLOWER ENTRIES FOR THEIR REACTION TO APHID

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**ABSTRACT**

The re-evaluation of 21 elite safflower entries was made under both field and cages conditions at different locations for their reaction to aphid *Uroleucon compositae* T. Six entries *viz.*, SSF-141, GMU-4608, 4625, 4627, JLSF-409 and 406 with comparatively good seed yield and less aphid population were identified as resistant to aphid. These entries could be exploited in breeding programme to develop high yielding safflower varieties with tolerance to aphids.

KEY WORDS : Safflower, elite entries, evaluation, aphid

Safflower (*Carthamus tinctorius* L.) is mainly cultivated for edible oil in this country over an area of 7.34 lakh ha with the production of 3.48 lakh tonnes. It is attacked by about 36 insect and non-insect pest species in India (Anon., 1987). Of them, the aphid, *Uroleucon compositae*.Theobald is the major pest (Akashe *et al.*, 1992) causing 35 to 72 per cent loss in yield (Suryawanshi and Pawar.

**Table 1. Method of scoring the entries**

| % Drying of the foliage (range) | Visual discription of symptoms | Grade | Category of the entry | Aphid Infestation Index (A.I.I.) |
|---|---|---|---|---|
| 0 to 20 | Healthy plants with normal capitula and seed yield equal to protected plants. | 1 | Highly tolerant | 1 |
| 21 to 40 | Healthy plants but yellowing and drying of leaves on main stem and branches and normal capitula | 2 | Tolerant | 1.1 to 2.0 |
| 41 to 60 | Drying of 50 % leaves on tender shoots of the plant and small to medium capitula with low seed setting. | 3 | Moderately tolerant | 2.1 to 3.0 |
| 61 to 80 | Drying of leaves and tender shoots, withering of branches, stunted growth, less number of capitula with very poor seed setting. | 4 | Susceptible | 3.1 to 4.0 |
| above 80 | Death of plant before maturity and no seed yield. | 5 | Highly susceptible | 4.1 to 5.0 |

$$A.I.I. = \frac{1xa + 2xb + 3xc + 4xd + 5xe}{a+b+c+d+e+.....+j}$$

Where, 1 to 5 = Different drying grades.
a to j = No.of plant in each grade.
x = Symbol of multiplication.

1980). It was observed that many safflower entries reacted differently to the apseed at different locations. Studies were, therefore, carried out to evaluate the elite safflower entries against the aphid across locations to locate common resistant entries for all locations.

## MATERIALS AND METHODS

In the winter of 1994-95, 50 safflower entries were screened at four different locations (Solapur, Jalgaon, Annigeri and Indore). Out of these, 21 entries exhibited field tolerance to aphids. In the present study, 21 entries exhibited field tolerance to aphids. In the present study, the same 21 tolerant entries were re- evaluated under both field and cages conditions in the late winter of 1995-96. The performance of 21 entries was compared with both susceptible and national checks. A method of Aphid Infestation Index (A.I.I.) devised by the safflower Entomologists was followed (Table 1) to categorise the entries under different foliage drying grades due to aphid infestation (Anon., 1991).

The 21 entries were grown along with susceptible (CO-1) and national (A-1) checks under late sown field conditions in a randomised block design with two replications at Solapur, Jalgaon, Annigeri and Indore. Each treatment was planted in a single row of 4 m length with spacing of 45 cm between rows and 20 cm within plants. The susceptible check was grown all around each experimental block and also around each replication as infestor for maximum build up of aphids. Both the checks were sown after every 10th test entry for comparison of damage by the pest.

The data on actual aphid count of 5 cm apical twig/plant of five randomly selected plants from each entry were collected at peak aphid incidence i.e. one month after the first incidence. The per cent aphid population (considering aphid number on A-1 as 100 %) was compared with A-1 (Anon., 1995). The observations were also recorded by visual score method based on pre-mature foliage drying due to the pest infestation of whole plant in 1 to 5 grades one month after peak incidence. Based on these grades A.I.I. for each entry was calculated. The seed yield (g/plant) was also recorded at harvest for comparison with checks and the data were statistically analysed (Table 2).

These 21 entries were also exposed to the artifical infestation in cages at two locations (Solapur and Indore) where basic facilities for screening were available. Plants were grown in earthern pots and covered with plastic cages of 60 x 25 cm size from germination till recording observations. Ten, one to two-day-old nymphs/plant were released at elongation stage and pots were completely covered with polythene cages, upper end of which was covered with musline cloth fastened with rubber band. The aphid population was recorded one month after the release. The means were pooled, % increase or decrease in population over A-1 was calculated and

Table 2. Mean performance of elite safflower entries for their reaction to aphid (Field studies : 1995-96).

| Entry | Aphids on 5cm apical twig/plant | | | | | % Aphid population to check A-1 | Foliage drying grade (A.I.I.) | Category | Seed yield (g/plant) |
|---|---|---|---|---|---|---|---|---|---|
| | Solapur | Jalgaon | Annigeri | Indore | Mean | | | | |
| GMU-4583 | 206 | 59 | 26 | 801 | 273 | 98.9 | 2.5 | MT | 4.7 |
| GMU-4593 | 211 | 94 | 28 | 845 | 295 | 106.9 | 3.1 | S | 13.9 |
| GMU-4597 | 190 | 104 | 62 | 630 | 247 | 89.5 | 3.2 | S | 8.6 |
| GMU-4601 | 216 | 94 | 24 | 742 | 269 | 97.5 | 2.8 | MT | 5.0 |
| GMU-4605 | 197 | 77 | 33 | 385 | 173 | 62.7 | 2.1 | MT | 7.4 |
| GMU-4608 | 150 | 65 | 41 | 242 | 125 | 45.3 | 1.3 | T | 7.9 |
| GMU-4609 | 170 | 49 | 30 | 670 | 230 | 83.3 | 2.0 | T | 5.8 |
| GMU-4610 | 173 | 53 | 36 | 780 | 261 | 94.6 | 1.9 | T | 5.5 |
| GMU-4623 | 194 | 51 | 32 | 785 | 266 | 96.4 | 2.2 | MT | 6.5 |
| GMU-4625 | 148 | 59 | 24 | 365 | 149 | 54.0 | 2.0 | T | 5.3 |
| GMU-4627 | 175 | 46 | 46 | 342 | 152 | 55.1 | 1.7 | T | 5.2 |
| GMU-4750 | 213 | 207 | 61 | 800 | 320 | 115.9 | 3.8 | S | 11.2 |
| JLSF-406 | 195 | 56 | NT | 295 | 182 | 65.9 | 1.4 | T | 6.8 |
| JLSF-409 | 179 | 47 | 45 | 389 | 165 | 59.8 | 1.3 | T | 5.7 |
| A-1 X CTV-193 | 245 | 143 | 59 | 785 | 308 | 111.6 | 3.5 | S | 5.5 |
| 425-6 x 398-9-15 | 198 | 62 | 26 | 730 | 254 | 92.0 | 2.5 | MT | 6.2 |
| 398-9-15 | 182 | 67 | 36 | 785 | 268 | 97.1 | 2.6 | MT | 5.0 |
| SSF-428 | 170 | 72 | 46 | 395 | 171 | 62.0 | 2.1 | MT | 3.6 |
| SSF-270-2 | 177 | 81 | 47 | 530 | 209 | 75.7 | 2.8 | MT | 2.2 |
| SSF-141 | 190 | 61 | 41 | 297 | 147 | 53.3 | 1.4 | T | 5.2 |
| SSF-139 | 166 | 62 | 37 | 423 | 172 | 62.3 | 1.8 | T | 4.0 |
| A-1(Check) | 194 | 88 | 24 | 798 | 276 | 100.0 | 2.6 | MT | 5.5 |
| CO-1(S.C.) | 311 | 208 | 121 | 1098 | 435 | 157.6 | 4.8 | HS | 0.6 |
| SE± | | | | | 56.28 | | | | 1.44 |
| CD (0.05) | | | | | 158.79 | | | | 4.11 |

T = Tolerant, MT = Moderately tolerant, S = Susceptible, HS = Highly susceptible, NT = Not tested

data thus obtained were statistically analysed (Table 3).

## RESULTS AND DISCUSSION

### Field study

The pooled results (Table 2) indicate that none of the entries was highly tolerant (i.e. A.I.I. = 1). Nine entries *viz.*, GMU- 4608, 4609, 4610, 4625, 4627, JLSF-406, 409, SSF-141 and 139 were tolerant (1.1 to 2.0). National check (A-1) was moderately tolerant.

The data on aphid population was not consistent at different locations. Entries *viz.*, GMU-4608 (125), SSF-141 (147), GMU- 4625 (149) and GMU-4627 (152) had significantly low aphid population than other entries (Table 2). Aphid population when compared to A-1 one per cent basis, all the entries except GMU- 4593, 4750 and A-1 X CTV-193 had scored less aphid per cent than A- 1 (100). The seed yield differences were also highly significant. Seven entries *viz.*, GMU-4593, 4597, 4605, 4608, 4623. 4750 and JLSF-406 recorded more yield than other of the entries. However, the maximum seed yield (13.9 g/plant) was recorded from GMU-4593 followed by GMU-4750 (11.2 g/plant) as against 5.5 g/plant in A-1 (Table 2).

### Cage study

Nine entries *viz.*, GMU-4608 (905), JLSF-406(937), GMU- 4625(954), GMU-4627 (990), SSF-139(1037), JLSF-409(1056), SSF-428(1083), SSF-141(1108) and 425-6 x 398-9-15 (1134) recorded significantly less aphid numbers (Table 3) than other entries. However, only three entries *viz.*, GMU-4608, 4625 and JLSF-406 were significantly superior over the national check (A-1).

It revealed that many of the entries showed a much lower aphid multiplication rate as compared to susceptible check (CO-1). The maximum per cent decrease in aphid population over national check was observed in the entry GMU-4608(31.8)

**Table 3. Mean performance of elite safflower entries against aphids under artificial epiphytotic conditions (Caged study : 1995-96).**

| Entry | Aphids multiplied on one plant | | | Average % decrease (-) or increase (+) in aphid population over national check |
|---|---|---|---|---|
| | Solapur | Indore | Mean | |
| GMU-4583 | 1615 | 930 | 1273 | -4.2 |
| GMU-4593 | 1347 | 1105 | 1226 | -7.7 |
| GMU-4597 | 1572 | 887 | 1230 | -7.5 |
| GMU-4601 | 2014 | 890 | 1452 | +9.3 |
| GMU-4605 | 1611 | 995 | 1303 | -2.0 |
| GMU-4608 | 1210 | 601 | 906 | -31.8 |
| GMU-4609 | 1727 | 901 | 1314 | -1.1 |
| GMU-4610 | 1437 | 990 | 1214 | -8.7 |
| GMU-4623 | 1963 | 1030 | 1497 | +12.6 |
| GMU-4625 | 1132 | 775 | 954 | -28.2 |
| GMU-4627 | 1277 | 703 | 990 | -25.5 |
| GMU-4750 | 1470 | 895 | 1183 | -11.0 |
| JLSF-406 | 1171 | 702 | 937 | -29.5 |
| JLSF-409 | 1182 | 930 | 1056 | -20.5 |
| A-1XCTV-193 | 1947 | 940 | 1444 | +8.7 |
| 425-6X398-9-15 | 1262 | 1005 | 1134 | -14.7 |
| 398-9-15 | 1459 | 987 | 1223 | -8.0 |
| SSF-428 | 1501 | 665 | 1083 | -18.5 |
| SSF-270-2 | 1666 | 1090 | 1378 | +3.7 |
| SSF-141 | 1321 | 895 | 1108 | -16.6 |
| SSF-139 | 1369 | 705 | 1037 | -22.0 |
| A-1(Check) | 1762 | 895 | 1329 | 0.0 |
| CO-1(S.C.) | 2046 | 1230 | 1638 | +23.3 |
| SE± | | | 121.46 | |
| CD (0.05) | | | 356.18 | |

S.C. = Susceptible check.

followed by JLSF- 406(29.5), GMU-4625(28.2), GMU-4627(25.5), SSF-141(25.2), SSF- 139(22.0), JLSF-409(20.5) and SSF-428(18.5).

Earlier workers (Naik, 1987; Parlekar and Ghorpade, 1992 and Akashe *et al.*, 1993a, 1993b and 1994) also tried to identify resistant sources to safflower aphid and reported some varieties/entries which were relatively resistant. On the basis of tolerant grades, less aphid population and comparatively good seed yield, the present investigation has re-evaluated some of the promising safflower entries. From both (field and cage) studies, six tolerant entries *viz.*, SSF-141, GMU-4608, 4625, 4627, JLSF-406 and 409 consistantly exhibited resistance against aphids. These entries could be exploited in breeding programme to develop high yielding varieties with tolerance to aphids.

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# DETECTION OF RATOON STUNTING DISEASE (RSD) BACTERIUM BY ELISA

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**ABSTRACT**

Ratoon stunting disease (RSD) caused by the bacterium *Clavibactor xyli* subsp. *xyli* display limited symptoms on the diseased stalks and no symptoms are noticed in the root or foliar region. An indirect enzyme linked immunosorbent assay (ELISA) technique was standardised to detect the RSD bacterial infection in sugarcane. Bacterial ooze/diffusates from the infected stalk tissues were used as antigen in the assay. Antiserum dilution of 1:1000 and enzyme conjugate dilution of 1:8000 were found optimum for the detection of the RSD bacterium in ELISA. In general the sugarcane varieties showed variation in the bacterium titer. All the varieties showing apparent disease symptoms have shown positive reaction for ELISA and many clones which were not showing any conspicuous symptoms also proved positive by ELISA. Varieties like Co 421, Co 997, Q 28 and CP 52-68 which are used as indicator hosts for the RSD, showed highest titer for the bacterium. Most of the sugarcane varieties evolved recently have shown negative reaction to the disease as compared to the old varieties. This technique was reliable for the detection of the suspected infection of the bacterium in sugarcane than the visual symptoms expressed by the cultivars, wherein the symptomless carriers might escape the detection and spread the disease.

KEY WORDS : Sugarcane, Ratoon stunting disease, ELISA

Ratoon stunting disease (RSD) was observed first time in India (Chona, 1956) and this disease is present in all sugarcane growing regions in India. Although RSD is present both in plant and ratoon crops, it is a major constraint to the ratoons of sugarcane. Since the disease spreads quickly through the seed material and the infection percentage increases causing a gradual decline in yields. Diagnosis of RSD is based on detection of internal stalk symptoms in sugarcane in the field or upon diagnostic assay using indicator hosts. Internal RSD symptoms have often been unreliable for field diagnosis since they are not produced in all varieties, vary among varieties, and may be ephemeral even in varieties known to produce distinct discolouration symptoms (Steindl, 1961; Ricaud, 1974). Later, biological assays using indicator hosts with a known and more reliable response to RSD have been used for diagnosis. However, these assays take weeks or even months to conduct and sometimes do not work as well in different laboratories. Although electron microscopy has been used to detect the RSD bacterium in host extracts and tissue sections (Worley and Gillaspie, Jr.1975) it is a cumbersome process. Isolation of *C.x.* subsp. *xyli* in axenic culture from plant tissue has also been used for diagnostic purposes; however, isolation usually takes time and laborious which limit the usefulness of this technique for diagnosis. Serological methods have been developed for improved sensitivity and specificity in detection of RSD bacterium in samples from sugarcane (Gillaspie, 1978). The purpose of the study reported herein was to standardise and evaluate the usefulness of an indirect ELISA for diagnosis of RSD in sugarcane.

## MATERIALS AND METHODS

### Plant materials

Sugarcane varieties with clear internal stalk symptoms and disease free clones were maintained