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# Evaluation of Selected Microbes for Control of Striga, A Parasitic Weed in Sorghum


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**ABSTRACT**

*Ten promising microbial isolates with very high degree of inhibition of Striga germination were evaluated for their ability to reduce Striga parasitism on sorghum under pot cultures. The results have indicated that four isolates completely suppressed Striga germination (100%), while the extent of suppression ranged between 98 to 99 per cent with the rest of the isolates. This was further, reflected in the increased plant height, plant dry weight and N and P concentration in sorghum. And, PSS-34 bacterium was the most efficient isolate which inhibited Striga seed germination and emergence completely, besides increasing growth and biomass of sorghum.*

**KEYWORDS : Striga, suppressive soil, parasitic weed, sorghum, microbial isolates.**

## Introduction

India has the largest area under sorghum in the world, grown extensively covering an area of about 16 m. ha with a total production of 11.6 million tones. The average grain yield is very low as compared to that of the world average. The low yield of sorghum may be attributed to many factors. One of the major causes for yield reduction in sorghum is due to the significant losses caused by the root parasitic weeds such as *Striga*. *Striga* establishes directly over the vascular system of the host plant, drains out water and nutrients from the host, resulting in yield losses ranging from 15 to 75 per cent depending on the extent of infestation. Grain yield losses can reach 100 per cent in susceptible cultivars under a high infestation level and drought conditions (1). Heavy crop losses have been reported by *Striga asiatica* on sorghum in Maharashtra (2), Karnataka (3) and Andhra Pradesh (4). Control of *Striga* has been very difficult because of its high fecundity. Each *Striga* plant is capable of producing 50,000 to 5, 00, 000 minute seeds that may remain viable for more than 10 years in the soil (5). Crop rotation and other chemical management practices have not been very effective in controlling the extent of *Striga* infestation. But, there are a number of resistance mechanisms of *Striga* which include low stimulant production, mechanical barriers to parasite ingress, chemical defense (antibiosis) in which microorganisms may produce certain chemical compounds to discourage the growth of *Striga* seedlings (6).

Of late, there have been many reports on inhibition of germination of *Striga* by rhizobacteria (7), fluorescent pseudomonads (8), fungi (9) including VAM fungi (10). Some sugarcane fields have been noticed in Bagalkot Ditrict, Karnataka, where *Striga* menace was evident and in the neighborhood, no *Striga* was noticed. Hence, in this investigation, an attempt was made to isolate microorganisms from such *Striga* suppressive soils, capable of inhibiting *Striga* germination, and test them for their efficacy.

## Materials and methods

**In vivo evaluation of microbial isolates on inhibition of Striga emergence and growth of sorghum:** Ten promising isolates (11) with a very high degree of inhibition of *Striga* germination were evaluated for their ability to reduce *Striga* parasitism on sorghum under pot cultures (7).

**Observations on growth parameters of sorghum:** The plant height was measured from the base to the growing tip of the shoot (in cm) at different stages of plant growth and the average worked out. The chlorophyll content in sorghum leaves was determined using a single photoelectric analyzing diode SPAD (Soil Plant Analysis Device) instrument. Sorghum as well as *Striga* plants were harvested at 90 days after sowing, by uprooting without disturbing roots using excess water. Shoot and root portion were separated and fresh weights of each taken. The plant samples were sun dried for 2-3 days and then dried in a hot air oven at 65-70$^0$ C till the constant weight was reached and the mean dry weight per plant was recorded and expressed as gram per plant (g/plant). Similarly, the fresh and dry weights of *Striga* were also taken.

**Plant analysis for chemical content:** The plant samples were washed, dried, powdered and subjected for chemical analysis. The total nitrogen content was estimated by following the Microkjeldahl's method (12), and Phosphorus by vanadomolybdate method after acid digestion (12).

## Results

Amongst the 10 microbial isolates tested, four belonged to bacteria including 1 fluorescent pseudomonad, two were fungi and four were actionomycetes. The microbial inoculation significantly reduced *Striga* emergence. It was interesting to note that in control, *Striga* emergence was observed on 54 days of sowing. Whereas in the inoculated treatments, the emergence was delayed and went up to 58 days as in case of inoculation with PSS-03 and PSJ-35 strains (Table 1). The highest number of emerged *Striga* seedlings were observed in the control at both 60 and 90 DAS. Four isolates *viz.,* PSS-34, PSS-42, PCP-20 and PSC-7 were successful in completely inhibiting *Striga* emergence even after 90 days of sowing. Only one *Striga* per 6 pots was emerged due to PSJ-35. There was a delay in *Striga* emergence by four days in the plants inoculated with PSS-03 and PSJ-35. A significant difference in sorghum plant height due to application of microbial inoculants at 60 and 90 DAS was observed (Table 2). At both 60 and 90 DAS, the highest plant height was recorded in pots inoculated with microbial isolate PSS-34. At 60 DAS, although the chlorophyll content of inoculated sorghum plants was statistically on par with UIC, at 90 DAS, in many inoculations *viz.,* PSS-34, PSS-42, PCP-7, PCP-20 and PCP-27, the chlorophyll content was statistically higher than the control (Table 2). All the isolates exhibited plant growth promoting effects (Table 3). The highest dry weight was recorded in plants inoculated with PSS-42 (7.52 g/pot. Microbial inoculation significantly reduced *Striga* biomass. The isolates PSS-34, PSS-42, PCP-20 and PSC-7 completely inhibited *Striga* and the least dry weight (0.03 g/pot) was observed in the isolate PCP-12. There was a significant difference in plant N and P contents also due to application of microbial inoculants (Table 3).

## Discussion

Microbial inoculation to *Striga* seeds significantly reduced *Striga*

emergence. It was interesting to note that no *Striga* emerged even after 50 days of planting, due to microbial inoculation. Out of four isolates which completely inhibited *Striga* emergence even after 90 days of sowing, two were bacteria, one was an actionomycete and the other one was a fluorescent *Pseudomonad* . In the literature also, fluorescent pseudomonads responsible for the lower levels of parasitism by *S. hermonthica* in maize in unsterile natural soil, coupled with increased sorghum growth have been reported (6,8) Besides inhibiting *Striga* weed emergence, the microbial inoculation also significantly reduced *Striga* biomass. Two out of four strains assayed significantly inhibited germination of the parasite, with one of them showing a plant growth promoting (PGPR) effect (13). The observed reduction and delay in *Striga* emergence caused by bacterial strains may be attributed to reduced germination, reduced haustorial initiation and attachment (6). Auxin and auxin-like compounds produced by bacteria have also been reported to inhibit *Striga* (14). Many scientists have also reported on the suppression of *Striga* seed germination by fungi. Results of a survey for fungal pathogens of *Striga* spp. indicated that *Fusarium* was the most prevalent fungus associated with diseased *Striga* plants. Of these, *F. oxysporum* was the most predominant (93%) species (15).

## Conclusion

Microbial isolates viz., PSS-34, PSS-42, PCP-20, and PSC-7, isolated form *Striga*-suppressive soils, were found promising in inhibiting *Striga* seed germination and emergence under pot culture conditions. And, PSS-34 bacterium was the most efficient isolate which inhibited *Striga* seed germination and emergence completely, besides increasing growth and biomass of sorghum. Thus, it can be concluded that some soils naturally possess microorganisms which can suppress the *Striga* germination, and it is possible to isolate, test and explore these microorganisms in managing *Striga* menace.

**Table 1: Effect of treating sorghum seeds with selected microbial isolates on emergence of *Striga* weed under pot culture conditions at (60 DAS and 90 DAS)**

| Sl No. | Treatments | Total No of emerged Striga seedlings in 6 pots (60 DAS) | No of emerged Striga seedlings/ pot (60 DAS) | Total No of emerged Striga seedlings in 6 pots (90 DAS) | No of emerged Striga seedlings/ pot (90 DAS) | No of days taken for Striga emergence |
|---|---|---|---|---|---|---|
| 1 | Control (UIC) | 22 | 3.67 (2.13)* | 32 | 5.33 (2.46)* | 54 |
| 2 | PSS-03 | 8 | 1.33 (2.13) | 16 | 2.66 (1.33) | 58 |
| 3 | PSS-34 | 0 | 0 (2.13) | 0 | 0 (1.19) | No emergence |
| 4 | PSS-42 | 0 | 0 (2.13) | 0 | 0 (1) | No emergence |
| 5 | PSJ-23 | 2 | 0.33 (2.13) | 6 | 11.0 (1) | 55 |
| 6 | PSJ-35 | 3 | 0.5 (2.13) | 1 | 0.16 (1) | 58 |
| 7 | PCP-07 | 2 | 0.33 (2.13) | 6 | 1.0 (1.33) | 55 |
| 8 | PCP-12 | 1 | 0.16 (2.13) | 5 | 0.83 (1.07) | 55 |
| 9 | PCP-20 | 0 | 0 (2.13) | 0 | 0 (1.81) | No emergence |
| 10 | PCP-27 | 1 | 0.16 (2.13) | 3 | 0.5 (1.29) | 55 |
| 11 | PSC-7 | 0 | 0 (2.13) | 0 | 0 (1) | No emergence |
| | SEm ± | | 0.10 | | 0.15 | |
| | CD at 5% | | 0.29 | | 0.43 | |

*** - Figures in parenthesis represent arc sine transformed values**
**UIC = Uninoculated Control**

**Table 2: Influence of inoculation of microbial isolates on plant height and chlorophyll content of sorghum (60 DAS and 90 DAS)**

| Sl No | Treatments | Plant height of sorghum (cm/ plant) (60 DAS) | Chlorophyll content in sorghum leaves (SPAD value) (60 DAS) | Plant height of sorghum (cm/plant) (90 DAS) | Chlorophyll content in sorghum leaves (SPAD value) (90 DAS) |
|---|---|---|---|---|---|
| 1 | Control (UIC) | 14.25 | 413.9 | 16.05 | 283.9 |
| 2 | PSS-O3 | 14.38 | 400.4 | 16.55 | 261.1 |
| 3 | PSS-34 | 23.70 | 407.0 | 25.37 | 381.9 |
| 4 | PSS-42 | 22.52 | 269.4 | 24.68 | 369.1 |
| 5 | PSJ-23 | 20.92 | 327.1 | 22.22 | 300.9 |
| 6 | PSJ-35 | 17.82 | 359.2 | 19.90 | 335.6 |
| 7 | PCP-7 | 17.55 | 393.3 | 18.50 | 351.2 |
| 8 | PCP-12 | 20.43 | 314.8 | 17.70 | 300.1 |
| 9 | PCP-20 | 22.97 | 388.7 | 24.65 | 352.8 |
| 10 | PCP-27 | 15.95 | 390.7 | 22.45 | 365.0 |
| 11 | PSC-7 | 21.97 | 364.8 | 23.18 | 336.2 |
| | SEm ± | 10.8 | 22.7 | 10.1 | 20.0 |
| | CD at 5% | 30.6 | 64.4 | 28.6 | 56.8 |

**UIC = Uninoculated Control**

**Table 3: Influence of inoculation of microbial isolates on growth and biomass of sorghum , *Striga* (dry weight).**

| Sl. No. | Treatments | Dry weight of sorghum shoot (g/pot) | Dry weight of sorghum root (g/ pot) | Dry weight of Striga biomass (g/ pot) | N concentration in sorghum(%) | P concentration in sorghum(%) |
|---|---|---|---|---|---|---|
| 1 | Control (UIC) | 4.08 | 6.15 | 1.17 (1.31)* | 0.09 | 0.24 |
| 2 | PSS-O3 | 5.35 | 6.18 | 0.33 (1.03) | 0.51 | 0.30 |
| 3 | PSS-34 | 7.27 | 8.53 | 0 (1.02) | 0.67 | 0.22 |
| 4 | PSS-42 | 7.52 | 8.68 | 0 (1) | 0.50 | 0.48 |
| 5 | PSJ-23 | 5.32 | 7.25 | 0.08 (1) | 0.24 | 0.37 |
| 6 | PSJ-35 | 4.40 | 6.03 | 0.78 (1) | 0.23 | 0.43 |
| 7 | PCP-7 | 6.63 | 7.77 | 0.06 (1.04) | 0.46 | 0.24 |
| 8 | PCP-12 | 5.37 | 6.53 | 0.03 (1.30) | 0.48 | 0.29 |
| 9 | PCP-20 | 6.73 | 7.78 | 0 (1.14) | 0.42 | 0.26 |
| 10 | PCP-27 | 4.35 | 7.47 | 0.04 (1.02) | 0.46 | 0.39 |
| 11 | PSC-7 | 7.30 | 8.33 | 0 (1) | 0.49 | 0.50 |
| | SEm ± | 0.18 | 0.47 | 0.09 | 0.13 | 0.06 |
| | CD at 5% | 0.52 | 1.34 | 0.27 | 0.36 | 0.17 |

*** - Figures in parenthesis represent arc sine transformed values**
**UIC = Uninoculated Control**

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