

## SEED TREATMENT FOR THE CONTROL OF *FUSARIUM* WILT IN CUMIN

R. P. GHASOLIA and S. C. JAIN

Department of Plant Pathology, Agril. Res. Station, Durgapura, Jaipur-302018, India.

\*Department of Plant Pathology, S.K.N. College of Agri., Jobner, Jaipur, Rajasthan, India.

Isolation of *Fusarium solani* was made by employing blotter and agar plate method from seeds of cumin. Pathogenicity was proved using seed inoculation technique which resulting in causing pre- and post-emergence mortality and wilt of cumin seedlings. Four seed dresser fungicides, 2 bioagents, 2 phyto-extracts and 2 physical treatments were evaluated *in vitro* as well as *in vivo* conditions for fungitoxicity against *F. solani* using as seed treatment. All test fungicides viz., carbendazim (bavistin 50 WP @ 0.20%), thiram 75 WP (@ 0.25%), captan 50 WP (@ 0.25%) and tebuconazole (raxil 2 DS, @ 0.20%); bio-agents *Trichoderma harzianum* and *T. viride* (@ 4g kg<sup>-1</sup> seed); in plant-extracts *Euphorbia antignorum* (dandathor, 100% concentration) and hot water (at 54 °C for 15 min.) gave higher seed germination and vigour index and minimum pre- and post-emergence mortality and least number of seedlings showing wilt symptoms over check. Raxil (tebuconazole) was also observed to increase/stimulate the vigour of plants compared with captan and thiram and other treatments (except bavistin).

**Keywords :** Cumin; *Fusarium solani*; Seed treatment; Wilt.

### Introduction

Cumin (*Cuminum cyminum* L.) is one of the important seed crops of India and is cultivated commercially throughout country. Rajasthan and Gujarat together account for more than 90 per cent of total area under cumin cultivation of the country<sup>1</sup>. Cumin is largely used as condiment and an essential ingredient in all mixed spices and curry powders. Seeds have stimulant, carminative, stomachic and astringent properties. It is also used in veterinary, medicine and perfumery<sup>2</sup>. Wilt/root rot of cumin incited by many species of *Fusarium* namely, *F. oxysporum* f. sp. *cumini*<sup>3-5</sup>, *F. equiseti*<sup>6</sup>, *F. solani*<sup>5</sup> and *Fusarium* sp.<sup>7</sup>, generally affects the crop at all stages of growth, but the disease usually appears in patches in the field by the end of December, when the crop is about a month old<sup>3,8</sup>. In Rajasthan wilt disease causes losses as high as 60 per cent and in Gujarat 25 per cent<sup>9</sup> but later on it was reported that it causes an average loss of 20 per cent in Rajasthan<sup>8</sup>. Since the fungi basically survive in soil for long periods but in some extent it is also transmitted through seeds<sup>4,5</sup>. At present carbendazim (bavistin 50WP @ 1 g/kg seed), captan (@ 2.5 g/kg seed) and thiram (@2.5 g/k seed) are the most common seed dressers used for managing the soil- and seed-borne infection of the fungi. In the present study, tebuconazole a new systemic

fungicide, bioagents, plant extracts, hot water and solar treatment were tested *in vitro* as well as *in vivo* as an alternate and economic for the control of cumin wilt.

### Materials and Methods

#### *In vitro* studies :

**Isolation and Pathogenicity :** Sixteen seed samples of cumin were collected from farmer's houses belonging to zone III 'A' of the Rajasthan and isolations were made employing blotter and agar plate method<sup>10</sup>. *Fusarium solani* was isolated, purified and identified. For pathogenicity test, 100 apparently healthy surface sterilized seeds of cumin were rolled on 7-day-old sporulating culture and were sown in 30 cm dia. earthen pots (pre-sterilized and filled with autoclaved soil, soil : FYM=3 : 1) @ 10 seeds/pot X 2 with 5 replications. Observations on pre- and post-emergence mortality and seedling showing wilt symptoms were recorded on 12<sup>th</sup> and 20<sup>th</sup> day of sowing, respectively.

Apparently healthy surface sterilized seeds of cumin were artificially inoculated with 7-day-old sporulating culture of *F. solani*. After 24h of inoculation, seeds were treated with 4 fungicides, 2 antagonist, 2 phyto-extracts and 2 physical treatments as described below.

**Plant Extract :** Hundered grams of succulent

part of *Aloe vera* (Guarpatha) and *Euphorbia antiquorum* (Dandathor) were washed well and grounded in 100 ml of distilled water (1: 1 w/v). The macerate was filtered through four-fold cheese cloth. Extracts thus obtained (Stock solution) were used as such for seed treatment by dipping the seeds for 24h.

**Bioagents :** Talc-based commercial formulation of *Trichoderma viride* and *T. harzianum* obtained from Rhizobia Scheme, Department of Agriculture, Govt. of Rajasthan, Durgapura, Jaipur was used @ 4 g/kg seed.

**Physical and chemical control :** Formulations of four seed dressing fungicides used were bavistin 50 WP (0.2%), raxil 2 DS (tebuconazole, 0.2%), captan 50 WP (0.25%) and thiram 75 WP (0.25%) and hot water (kept at 54 °C for 15 min.) and solar treatment were followed. In solar treatment seeds were soaked in ordinary water for 4 H (8 am to 12 noon) on a bright summer day and then spread on carbon paper in sun for 4 H (12.15 pm-4.15 pm).

The treated seeds were plated on moistened blotting papers in petriplates @ 25 seeds per plate with four replication. Inoculated untreated seeds served as control. After 10 days of incubation at 20±2 °C, the observations were recorded for seed germination, pre-and post-emergence mortality and root and shoot length. Vigour index was calculated according to Abdul-Baksi and Anderson<sup>11</sup> : Vigour index = Germination % x (root + shoot length).

**In field conditions (In vivo) :**

Another set of the same experiment was also laid out in the field during Rabi 1998-99 in randomised block design with three replications in 2 M x 1.5M plots. After 12 days of sowing, the observations were started on seed germination, pre-and post-emergence mortality and root and shoot length and seedlings showings wilt symptoms (40 days after sowing).

### Results and Discussion

*Fusarium solani* isolated from cumin seeds

was found pathogenic to cumin as the Koch's postulates proved and it caused 15 per cent pre-and 18.85 per cent post-emergence mortality and 19.54 per cent seedlings showed wilt symptoms.

*In vitro* studies revealed (Table 1) that all test fungicides, *T. viride*, *E. antiquorum* and hot water were found significantly superior over check in reducing pre-and post-emergence mortality and in increasing seed germination and vigour index. Amongst fungicides, carbendazim @ 2 g/kg seed was found highly effective in giving maximum seed germination (92%) and in checking cent per cent pre-and-post emergence mortality and increasing vigour index (580.8) as compared to check (74%, 20%, 10.92% and 275, respectively) followed by thiram, raxil and captan. New systemic fungicide, raxil (tebuconazole) was observed at par in efficacy with thiram, captan and hot water.

*T. viride* gave the reduced pre-and post-emergence mortality of 12.00 and 5.09 per cent and increased vigour index (395.3) while in plant extracts, *E. antiquorum* showed less pre-and post-emergence mortality of 13.00 and 5.20 per cent and more vigour index (408.2) over check. In physical treatments, hot water observed effective which showed increased seed germination (86%) and vigour index (489.6) and reduced pre-and post-emergence mortality of 6.00 and 1.04 per cent which found at par with thiram, raxil and captan in their effectiveness.

It is obvious from the results of field conditions, given in Table 2, that all the treatments (except solar treatment) were observed effective to reduce pre-and post-emergence mortality, number of wilted plants and increased seed germination and vigour index. Amongst fungicides, carbendazim was observed highly effective in minimising pre-(1%) and post-emergence mortality (1.92%), number of plants showing wilt symptoms (2.74%) and maximising seed germination (87%) and vigour index (575.00) compared with check (16%, 22%, 16.77%, 69% and 260.7, respectively).

Table 1. Effect of seed treatment against *Fusarium solani* on seed germination, pre-and post-emergence mortality and vigour index *in vitro*.

| S. No. | Treatments                   | Dose g/kg seed | % Germination | Per cent mortality |                | Root length (cm) | Shoot length (cm) | Vigour index |
|--------|------------------------------|----------------|---------------|--------------------|----------------|------------------|-------------------|--------------|
|        |                              |                |               | Pre-emergence      | Post-emergence |                  |                   |              |
| 1.     | Bavistin (carbendazim)       | 2              | 92 (74.70)    | 0.00 (0.00)        | 0.00 (0.00)    | 3.20             | 3.10              | 580.8        |
| 2.     | Raxil (tebuconazole)         | 2              | 86 (68.76)    | 4.00 (9.87)        | 0.00 (0.00)    | 3.00             | 2.80              | 498.8        |
| 3.     | Captan                       | 2.5            | 88 (70.07)    | 5.00 (11.10)       | 1.09 (2.99)    | 2.50             | 2.30              | 423.6        |
| 4.     | Thiram                       | 2.5            | 90 (72.26)    | 1.00 (2.88)        | 0.00 (0.00)    | 2.80             | 2.80              | 505.0        |
| 5.     | <i>Trichoderma harzianum</i> | 4.0            | 78 (62.32)    | 14.00 (21.71)      | 6.67 (12.86)   | 2.30             | 2.40              | 367.6        |
| 6.     | <i>T. viride</i>             | 4.0            | 80 (63.72)    | 12.00 (20.14)      | 5.09 (11.10)   | 2.50             | 2.30              | 395.3        |
| 7.     | <i>Aloe vera</i>             | 100%           | 77 (61.52)    | 16.00 (23.50)      | 8.07 (13.97)   | 2.60             | 2.40              | 385.8        |
| 8.     | <i>Euphorbia antiquorum</i>  | 100%           | 80 (63.72)    | 13.00 (20.49)      | 5.21 (11.25)   | 2.60             | 2.50              | 408.2        |
| 9.     | Hot water                    | -              | 86 (68.76)    | 6.00 (12.06)       | 1.04 (2.92)    | 2.90             | 2.80              | 489.6        |
| 10.    | Solar energy                 | -              | 78 (62.14)    | 16.00 (23.50)      | 6.60 (12.51)   | 2.20             | 2.00              | 329.8        |
| 11.    | Control                      | -              | 74 (59.42)    | 20.00 (26.38)      | 10.92 (18.93)  | 1.90             | 1.80              | 275.0        |
|        | C.D. at 5%                   | -              | 5.88          | 5.48               | 7.16           | -                | -                 | 73.21        |

Figures given in parentheses are angular transformed values.

Table 2. Effect of seed treatment against *Fusarium solani* on seed germination, pre- and post-emergence mortality, seedlings showing symptoms and

| S. No. | vigour index <i>in vivo</i> .<br>Treatments | Dose g/kg seed | % Germination | Per cent mortality |                | % seedlings showing wilt symptoms* | Root length (cm) | Shoot length (cm) | Vigour index |
|--------|---|----------------|---------------|--------------------|----------------|------------------------------------|------------------|-------------------|--------------|
|        |   |                |               | Pre-emergence      | Post-emergence |                                    |                  |                   |              |
| 1.     | Bavistin (carbendazim)                      | 2.0            | 87 (68.90)    | 1 (4.62)           | 1.92 (7.75)    | 2.74                               | 3.40             | 3.20              | 575.00       |
| 2.     | Raxil (tebuconazole)                        | 2.0            | 82 (64.91)    | 4 (11.25)          | 4.07 (11.33)   | 2.97                               | 3.20             | 3.00              | 509.00       |
| 3.     | Captan                                      | 2.5            | 84 (66.52)    | 3 (9.54)           | 3.92 (11.19)   | 2.89                               | 2.80             | 2.70              | 468.93       |
| 4.     | Thiram                                      | 2.5            | 82 (64.94)    | 2 (7.95)           | 4.94 (12.32)   | 3.85                               | 2.90             | 2.80              | 466.60       |
| 5.     | <i>Trichoderma harzianum</i>                | 4.0            | 76 (60.71)    | 8 (16.24)          | 10.22 (18.38)  | 5.85                               | 2.60             | 2.40              | 378.40       |
| 6.     | <i>T viride</i>                             | 4.0            | 76 (60.71)    | 7 (15.10)          | 9.32 (17.59)   | 4.83                               | 2.60             | 2.50              | 386.26       |
| 7.     | <i>Aloe vera</i>                            | 100%           | 71 (57.43)    | 10 (18.30)         | 10.85 (19.02)  | 7.89                               | 2.70             | 2.60              | 377.10       |
| 8.     | <i>Euphorbia antiquorum</i>                 | 100%           | 72 (58.09)    | 10 (18.30)         | 11.91 (20.01)  | 5.79                               | 2.50             | 2.40              | 354.13       |
| 9.     | Hot water                                   | -              | 82 (64.91)    | 6 (13.87)          | 6.87 (15.01)   | 6.11                               | 3.00             | 2.80              | 476.26       |
| 10.    | Solar energy                                | -              | 70 (56.82)    | 12 (20.23)         | 15.74 (23.36)  | 9.84                               | 2.40             | 2.30              | 330.33       |
| 11.    | Control                                     | -              | 69 (56.86)    | 16 (23.55)         | 22.10 (27.90)  | 16.77                              | 2.00             | 1.90              | 260.7        |
|        | C.D. at 5%                                  | -              | 4.02          | 4.30               | 5.17           | -                                  | -                | -                 | 25.00        |

Figures given in parentheses are angular transformed values.

\* Based on 40-day-old seedlings.

Captan ranked second in order of their efficacy followed by raxil and thiram. However the raxil was also observed to increase/stimulant the vigour of plants. In antagonists, *T. viride* was found more effective in minimising pre-(7%) and post-emergence mortality (9.32%), number of plants showing wilt symptoms (4.83%) and increasing vigour index (386.26) followed by *T. harzianum* as compared to check while in plant extracts *E. antiqorum* was found effective that showed less pre-and post-emergence mortality of 10 per cent and 11.91 per cent, reduced number of plants showing wilt symptoms (5.79%) and gave more vigour index (354.13) over check. In physical treatment, hot water was observed effective in maximising seed germination (82%) and vigour index (476.26) and in minimising pre-and post-emergence mortality of 6 per cent and 6.87 per cent and number of plants showing wilt symptoms (6.11%) over check.

During present investigation, blotter and agar plate methods were employed for the isolation of *Fusarium solani* from cumin seeds. Pathogenicity was proved using seed inoculation technique and *F. solani* was found pathogenic as it caused pre-and post-emergence mortality and seedlings showed wilt symptoms. Pathogenic nature of *F. solani* isolated from cumin seeds have already been reported and established it as root rot pathogen<sup>5</sup> while in present study, it was noted that it caused wilt disease in cumin and observed seed borne in nature.

Seed treatment is the cheapest and easiest method of plant disease control. In the present investigation, it was observed that seed treatment with fungicides, antagonists, plant-extracts and hot water treatment increased seed germination percentage and vigour index on one hand and reduced pre-and post-emergence mortality and number of seedlings showing wilt symptoms on the other. Among fungicides under study, bavistin was found to be the most effective against *F. solani* *in vitro* and *in vivo* conditions and rest were at

par with each other. Raxil was also observed to increase/stimulant the vigour of plants in comparison to captan and thiram and other treatments (except bavistin). Bavistin and thiram have reported to be the best seed dresser against seed-borne *F. oxysporum* f. sp. *cumini* of cumin<sup>12-15</sup>.

In the modern era, where hazards of pollution are increasing day by day, the biological control will help to reduce it. In present investigation, *T. viride* and *T. harzianum* were found to be effective against *F. solani* *in vitro* and *in vivo* conditions in increasing seed germination and vigour index by reducing pre-and post-emergence mortality and number of plants showing wilt symptoms. The biocontrol agents *T. harzianum* and *T. viride* probably act by inhibition of mycelial growth of the pathogen by production of toxins or antibiotics or coiling of hyphae of *Fusarium solani*. Similar results have also been achieved by treating the seeds with *T. viride*, *T. harzianum*, *T. hamatum* and *T. koningii* against fenugreek wilt pathogen, *F. oxysporum*<sup>16,17</sup>.

In recent years, many plant-extracts are being used as fungicide for the control of various plant pathogens *in vitro* and *in vivo*. In present study, extracts of *Euphorbia antiqorum* (dandathor) and *Aloe vera* (guarpatha) were found effective in reducing pre-and post-emergence mortality and number of plants showing wilt symptoms. Antifungal activity of *Cymbopogon martinii*, *Euphorbia hirta* and *Aloe barbadensis* reported against arhar wilt, *F. oxysporum*<sup>18</sup>, cumin wilt, *F. oxysporum* f. sp. *cumini*<sup>19</sup>, and pea wilt pathogen, *F. oxysporum* f. sp. *pisi*<sup>20</sup>, respectively.

In physical seed treatment, hot water was found effective in increasing seed germination and vigour index by reducing pre-and post-emergence mortality and number of plants showing wilt symptoms whereas solar energy was found non-significant over check. Hot water reported to be best physical seed treating method against seed-borne *F. oxysporum* f. sp.

*cumini*<sup>4, 21</sup>. These corroborate the findings of present investigation.

It can be concluded that out of 10 treatments, bavistin (carbendazim) @ 2 g/kg seed was found more effective in increasing seed germination and vigour index and in reducing plant mortality and number of plants showed wilt symptoms. However, complete control of the disease was not recorded with the use of raxil (tebuconazole) @ 2 g/kg seed. But raxil is equally effective new seed dressing fungicide for checking the internally seed borne infection of wilt of cumin.

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