To evaluate in-vivo efficacy of fungicides, bio-agents and phyto-extracts against sudden death syndrome (wilt) of soybean caused by *Fusarium oxysporum* f. sp. *virguliforme*

SS Gote, PH Ghante, VS Mete, AA Kmable and Gayakwad CS

**Abstract**

Sudden death syndrome (wilt) of soybean caused by *Fusarium oxysporum* f. sp. *virguliforme*. *In-vivo* evaluation of effective fungicides, bioagents and phyto-extracts (in field condition), per cent seed germination with effective treatments was ranged from 95.72 to 100 per cent. The effective treatment with Azoxystrobin and Propiconazole shown 100 per cent seed germination and Garlic clove extract was found less effective which shown comparatively less germination *i.e.* 95.72 per cent, where in case of control it was least *i.e.* 93.76 per cent. The wilt disease incidence in field condition was ranged from 8.60 to 43.30 per cent. The least wilt disease incidence was recorded with Azoxystrobin *i.e.* 8.60 per cent and Garlic clove extract was found highest percentage of wilt disease incidence *i.e.* 43.30 per cent.

**Keywords:** Soybean, in-vivo, *Fusarium oxysporum*, fungicides, bioagents and phyto-extracts

**Introduction**

Soybean [*Glycine max* (L.) Merrill] is a native of northern China and is the most important legume crop in the world. Soybean is called ‘Golden bean,’ ‘Miracle bean’ and ‘Crop of planet.’ The crop thus, improves soil fertility and economizes crop production not only for themselves but also for the next crop grown in rotation especially, cereal crops (Nassiuama and Wasihe, 2002) [9]. Soybean is nutritious, easily digestible and is considered as one of the richest and cheapest source of proteins, hence called as ‘Poor man’s meat’ and also substitute for milk. India, it is grown on an area of 11.25 million hectare with a production of 14.22 million metric tonnes and productivity of 1263 kg/ha in the year 2017 (Anonymous, 2017) [11]. Amongst the soybean producing nation India occupies dismal fifth position in production though we are third after USA and China in area. Among the different states in India, Madhya Pradesh ranks both in area and production. Soybean crop can be attacked by more than 100 pathogens (Sinclair and Schurtleff, 1975) [13]. About 35 pathogens were reported to infect soybean in India (Gupta et al., 2001) [9]. Fungi, nematodes, viruses, bacteria, and phytoplasmas are known to cause diseases of soybean. The soybean crop is presently suffered due to one of the important disease known as sudden death syndrome. The sudden death syndrome disease is called as wilt of soybean. The soybean wilt is caused by *Fusarium oxysporum* f. sp. *virguliforme* (Aoki 2003) [2]. *Fusarium* genus is a soil borne fungus that causes wilt of many crops. In many cases the fungus causing wilt in a particular crop is specific to that crop. In case of soybean, sudden death syndrome caused by the soil borne pathogen *F. solani* f. sp. *glycines* formerly called *Fusarium virguliforme* sp. in recent days which was first observed in Arkansas during 1971 (Roy et al. 1997) [11]. It can cause great damages, as it may reduce the average yield of soybean by up to 59 per cent (Sinclair and Backman 1989) [12].

**Material and Methods**

With an object to develop an economical and holistic disease management practice present field experiment was planned and undertaken. In the present studies, those fungicides (systemic and combined), bio-control agents (fungal and bacterial) and phyto-extracts which were found effective against *Fusarium oxysporum* f. sp. *virguliforme* during *in vivo* evaluation for the management of wilt of soybean in field conductions.
The field experiment was conducted at Plant Pathology section of Agricultural Research Station, Badnapur during Kharif 2018-19 by using susceptible soybean variety JS 20-34 with RBD design. Sowing was done in such manner that each plot has six lines and each line had forty seeds with proper spacing and experiment was conducted under natural field condition where solution of 106 CFU of Fusarium oxysporum f. sp. virguliforme poured into each rhiizosphere of plant once at vegetative stage of soybean.

**Result and Discussion**

The field experiment was conducted at field section of Plant Pathology, Agricultural Research Station, Badnapur during Kharif 2018-19 by using susceptible variety viz., JS 20-34. Five fungicides, two bioagents and two plant extracts which were resulted most effective against Fusarium oxysporum f. sp. virguliforme in vivo were used for disease management to control the disease as applied through seed treatment under natural field conditions. The results were recorded in Table 1 and depicted in the (PLATE XII, Fig. 1).

**Per cent seed germination:** All the treatments improved per cent germination as compared to control and it was ranged from 95.72 per cent to 100 per cent. Among all treatments, seed treated with fungicides Azoxystrobin and Propiconazole shown 100 per cent seed germination. These were followed by Thiophanate methyl (99.50%), Carbendazim (98.23%), Carbendazim 12% WP + Mancozeb 63% WP (97.90%), Trichoderma viride (97.53%), Trichoderma harzianum (96.86%) and Neem (96.55%) The seed treated with clove extract of garlic found least effective for seed germination 95.72 per cent and still significantly superior over the control.

**Per cent wilt / SDS disease incidence**

All the treatments were found effective against disease and significantly reduced the disease incidence over the control and it was ranged from 8.60 per cent by the seed treatment with (Azoxystrobin) to 43.30 per cent (Garlic). Amongst of all treatments, seed treatment with Azoxystrobin was found most effective with least mean disease incidence (8.60%) followed by seed treatment with Propiconazole (9.46%), Thiophanate methyl (11.43%), Carbendazim (21.40%), Carbendazim 12% WP+ Mancozeb 63% WP (26%), Trichoderma viride (32.10%), Trichoderma harzianum (31.50%), Garlic (43.30 %) and Neem (38.76%). The treatment Garlic were found least effective with highest percentage of disease incidence 43.30 per cent and untreated control was shown the highest wilt incidence i.e. 52.43 per cent.

The application of fungicides, bioagents and phyto-extracts found most effective against Fusarium oxysporum f. sp. virguliforme. It minimized the per cent disease incidence and increased seed germination too.

Present investigations are in agreement with those earlier studied by Poddar et al. (2004) [9] reported that seed treatment with Trichoderma harzianum mutant UM2R + carbendazim (1.25g kg-1) resulted in the maximum seed yield (4.6 g plant-1) and lowest disease incidence (2.5 %) of wilt of chickpea. Nikam et al. (2007) [7] reported that combined soil application of T. viride and ground nut cake followed by Neem cake had given good control against chickpea wilt caused by Fusarium oxysporum f. sp. ciceri. Other scientist like Prasad et al. (2002) [10], Patil et al. (2015) [8], Bana et al. (2017) [3] and Ghante et al. (2018) [4] also observed the same results.

**Table 1:** Effect of seed treatment of fungicides, bioagents and phyto-extracts against per cent wilt disease incidence

| Tr. No. | Treatment         | Per cent Germination* | Per cent Wilt incidence |
|--------|-------------------|-----------------------|-------------------------|
| T1     | Azoxystrobin      | 100 (90)              | 8.60 (17.05)            |
| T2     | Propiconazole     | 100 (90)              | 9.46 (17.91)            |
| T3     | Thiophanate methyl| 99.50 (85.94)         | 11.43 (19.76)           |
| T4     | Carbendazim       | 98.23 (82.35)         | 21.40 (27.55)           |
| T5     | Carbendazim 12% WP + Mancozeb 63% WP | 97.90 (81.66) | 26.00 (30.65) |
| T6     | Trichoderma viride| 97.53 (80.55)         | 32.10 (34.51)           |
| T7     | Trichoderma harzianum | 96.86 (79.79) | 31.50 (34.14) |
| T8     | Garlic            | 95.72 (78.06)         | 43.30 (41.14)           |
| T9     | Neem              | 96.55 (79.29)         | 38.76 (38.50)           |
| T10    | Control (Untreated)| 93.76 (75.53)         | 52.43 (46.39)           |
|        |                   | SE±                   | 0.86                    |

*Mean of three replications  
Figures in parenthesis are arcsine transformed values

**Plate 1:** Soybean sudden death syndrome wilt disease management trial during ~ 3282 ~
Fig 1: Effect of seed treatments of fungicides, bioagents and phyto-extracts on per cent seed germination and SDS (wilt) incidence in soybean field condition

References
1. Anonymous. Selected state-wise area, production and yield of soybean in India. India Agristat for 2017.
2. Aoki T. Sudden death syndrome of soybean is caused by two morphologically and phylogenetically distinct species within the Fusarium species complex F. virguliforme in North America and F. tucumaniae in South America. Mycologia 2003;95(4):660-684.
3. Bana SR, Manoj KM, Neeraj KM, Patil NB. Evaluation the Efficacy of Fungicides and Bio-agents against Fusarium oxysporum under in vitro and in vivo Conditions. Int. J Curr. Microbiol. App. Sci 2017;6(4):1588-1593.
4. Ghante PH, Suryawanshi AP, Kanase KM, Somwanshi SD, Thaware DS. Integrated Disease Management against Wilt Disease of Pigeonpea Caused by Fusarium oxysporum f. sp. udum. Int. J Curr. Microbiol. App. Sci 2018;7(10):2123-2132.
5. Gupta CP, Sharma A, Dubey RC, Maheshwari DK. Plant growth enhancement and suppression of M. phaseolina causing charcoal rot of peanut of fluorescent pseudomonas. Ind. J Exp. Biol 2001;39:1318-1321.
6. Nassiuma D, Wasike W. Stability assessment of soybean varieties in Kenya. Afr. Crop Sci. J 2002;10(2):139-144.
7. Nikam PS, Jagtap GP, Sontakke PL. Management of chickpea wilt caused by Fusarium oxysporum f. sp. ciceri. African Journal of Agricultural Research 2007;2(12):692-697.
8. Patil VB, Gawade DB, Suryawanshi AP, Zagade SN. Biological and fungicidal management of chickpea wilt caused by Fusarium oxysporum f. sp. ciceri. An International Quaterly Journal of Life Science 2015;10(2):685-690.
9. Poddar RK, Singh DV, Dubey SC. Integrated application of Trichoderma harzianum mutants and carbendazim to manage chickpea wilt (Fusarium oxysporum f. sp. ciceri). Indian Journal of Agricultural Science 2004;74(6):346-348.
10. Prasad RD, Rangeshwaran R, Annuroop CP, Rashmi HJ. Biological control of wilt and root rot of chickpea under field condition. Annual of Plant Protection Science 2002;10(1):72-75.
11. Roy KW, Rupe JC, Hershman DE, Abney TS. Sudden death syndrome of soybean. Plant Dis 1997;81:1100-1111.
12. Sinclair JB, Blackman PA. Compendium of soybean diseases Thired. The American Phytopathological society Str 1989, J-106.
13. Sinclair JB, Schurleff MC. Compendium of soybean diseases. Amer. Phytopathol. Soc., St Paul, Minnesota 1975, 69.