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Combined Application Of Fungal And Bacterial Bioagents, Together With Fungicide For Integrated Management Of Stem Rot Disease Of Groundnut

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Abstract

Groundnut stem rot, caused by *Sclerotium rolfsii*, is notorious for causing significant economic losses in groundnut production worldwide. During field evaluation at two locations, Patancheru and Rajendranagar, the bioagents *Trichoderma viride*, *Bacillus cereus* and fungicide azoxystrobin performed exceptionally well. Among the various treatments, treatment T10, which consisted of *Trichoderma viride* and *Bacillus cereus* as ST (seed treatment) + SA (soil application) + reduced rate of azoxysrobin, proved to be the most effective in controlling stem rot of groundnut. Treatment T8, comprising of *Trichoderma viride* as ST + SA + reduced rate of azoxystrobin, and treatment T9, consisting of *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin, also exhibited good control of the disease under both glasshouse and field conditions. Additionally, these treatments resulted in substantial growth and yield attributing parameters, with the highest pod yield and B:C ratio being recorded. In conclusion, the bioagents *Trichoderma viride* (T2), *Bacillus cereus* (B5) and fungicide azoxystrobin have demonstrated great potential for the effective management of stem rot in groundnut and can be utilized in field settings.

Key Words- Groundnut, Sclerotium rolfsii, Trichoderma viride , Bacillus cereus and azoxystrobin

INTRODUCTION

Groundnut, scientifically known as *Arachis hypogea* L., holds a prominent position as one of the most crucial oilseed crops worldwide. China stands as the leading producer of this crop, with India, Nigeria, and the United States following suit (Groundnut Outlook, Agricultural Market Intelligence Centre, PJTSAU, 2019).
The cultivation of groundnut spans across a vast expanse of 29.59 million hectares globally, resulting in a substantial total production of 48.75 million tonnes (FAOSTAT, 2019). Within India, groundnut is cultivated over an area of 4.8 million hectares, yielding an impressive 9.2 million tonnes (INDIASTAT, 2019). In the specific region of Telangana, groundnut cultivation covers an extent of 0.13 million hectares, resulting in a production of 0.30 million tonnes and a noteworthy productivity level of 2364 kg/ha (Directorate of Economics and Statistics, 2019).
The groundnut crop is subject to a variety of diseases resulting from fungi, bacteria, nematodes, and viruses. These diseases have a negative impact on both the yield of groundnut pods and the quality of the resulting fodder. Stem rot, caused by *Sclerotium rolfsii* Sacc, is particularly problematic among fungal diseases. This disease significantly impairs the yield and quality of groundnut production, and is considered to be one of the most economically significant diseases for this crop. It is estimated that stem rot leads to an annual loss of 10 to 25 percent in yield (Sturgeon, 1986).
It was initially observed in the year 1892 by Peter Henry Rolfs on tomato plants resulting in a significant 70% loss. The hyphae exhibited an upward growth pattern on the surface of the infected plant, which was enveloped by a cottony, white mass of mycelium. This mycelium was dispersed both internally and externally in the vicinity of the infected stem, particularly near the soil surface. Moreover, the fungus manifested the production of numerous small, round, and uniformly-sized white sclerotia during its immature stage. As the fungus matured, these sclerotia transformed into a dark brown hue (Kwon and Park, 2002). Within India, the incidence of stem rot is most severe in the states of Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Odisha, and Tamil Nadu. It is important to note that this disease inflicts substantial damage, as it can reach an alarming rate of over 80% in heavily infected fields (Mehan and McDonald, 1990).
The management of diseases caused by pathogens present in seeds and soil has traditionally focused on seed treatment due to the high cost and impracticality of applying chemicals directly to the soil. Consequently, alternative strategies for disease management have been explored, with particular attention given to biological control. This approach is regarded as promising due to its potential effectiveness and its environmentally friendly nature, making it a virtuous complement to synthetic fungicides (Abada and Ahmad, 2014; Sohaliya et al., 2019).
Various reports indicate the extensive utilization of Trichoderma spp., including *T. asperellum*, *T. atroviride*, *T. gamsii*, *T. hamatum*, *T. harzianum*, *T. polysporum*, *T. virens*, and *T. koningii*, as biocontrol agents that effectively combat diverse soil-borne pathogens like *Phytophthora, Pythium, Aspergillus, Fusarium*, and *Rhizoctonia* (Moosa et al., 2017; Javaid et al., 2018; Sharma and Prasad, 2018; Ingale and Patale, 2019). Furthermore, the implementation of organic amendments has been observed to suppress soil-borne pathogens (Bonanomi et al., 2018). Numerous studies have also indicated that the antagonistic efficacy of bacterial or fungal antagonists, such as *P. flourescens* or Trichoderma spp., can be enhanced when combined with organic amendments (Karthikeyan et al., 2006; Vengadeshkumar et al., 2019; Jangir et al., 2020). The utilization of organic amendments promotes the establishment of beneficial microflora in the rhizosphere, which aids in the reduction of plant pathogens in the soil (Tayyab et al., 2019). Hence, an endeavor was undertaken to ascertain the most effective biocontrol agent and fungicide for the management of *Sclerotium rolfsii*, the causal agent of stem rot of groundnut, through the evaluation of seed treatment with chemical, bioagent, neem cake application, and their combinations in field experiments during the kharif season of 2022 and the rabi season of 2022-23.

MATERIALS AND METHODS.

Location I

During the kharif 2022 season, a trial took place at ICRISAT in Patancheru, India. The trial was carried out using a randomized complete block design (RCBD), which consisted of ten treatments and three replications with a spacing of 30 x 10 cm. The peanut cultivar K6, which is susceptible to stem rot, was used for the experiment. The treatments for the experiment were as follows:
T1: Un-inoculated control
T2: Inoculated control

T3: Effective fungicide at reduced rate
T4: *Trichoderma viride* as seed treatment (ST)
T5: *Trichoderma viride* as soil application (SA)
T6: *Bacillus cereus* as seed treatment (ST)
T7: *Bacillus cereus* as soil application (SA)
T8: *Trichoderma viride* as ST + SA + reduced rate of azoxystrobin
T9: *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin
T10: *Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin.

Where, ST is seed treatment and SA is soil application.
The bioformulations were mixed with thoroughly decomposed farm yard manure (FYM) and used as a basal application 15 days prior to planting at a rate of 2.5 kg/ha. The seeds had been treated with bioformulations at a rate of 10g/kg of seeds before sowing. T1, T2, and T3 were utilized for comparing the treatments. T3 served as the control with fungicide, where the seeds had been treated with azoxystrobin 23.8 SC (@1ml/kg seeds) at the time of planting and azoxystrobin 23.8 SC (@1 ml/l) was sprayed as a soil drench on the 44th day after sowing. T1 represented the uninoculated control (no pathogen inoculation), and T2 represented the inoculated control (pathogen inoculation). The virulent isolate inoculum was prepared on SGM as explained in (3.5.2.). On the 45th day after sowing, artificial inoculation was conducted in the field, with 400 g of virulent isolate inoculum applied per 4 meter row. The inoculum was applied in the plant's collar region.
A scale of severity ranging from 1 to 5 was utilized to assess the severity of all diseases (Shokes et al., 1996), and the percentage of disease severity was calculated following the method by Le et al (2012). When observing disease severity (DS), approximately 20% of the plant population was taken into consideration, and the data was recorded at regular intervals. Other observations such as disease incidence (DI) and mortality (M) were also documented. All observations were conducted 15 days after inoculation and continued at 15-day intervals until harvesting. During the harvest, plants were uprooted and examined for stem discoloration, pod lesions, and pod rot. Subsequently, various attributes related to yield were recorded, including plant height (in centimeters), germination percentage, number of pods per plant, pod yield per plot, 100 kernel weight, shelling percentage, oil content percentage, protein content percentage, and the B:C ratio.

Location II
During the Rabi season of 2022-23, an agricultural trial was conducted at the college farm of PJTSAU in Rajendranagar, India. The setup for the experiment closely resembled the location mentioned earlier.

RESULTS AND DISCUSSION

The study was conducted to evaluate the efficacy of talc formulations containing the bioagents *Trichoderma viride* and Bacillus cereus, both individually and in combination, in the management of stem rot disease in groundnut. The experiments were carried out at two different locations, namely ICRISAT, Patancheru (Location I) during the kharif season of 2022, and PJTSAU, Rajendranagar (Location II) during the rabi season of the same year. The effectiveness of these treatments was assessed by measuring their impact on the severity, incidence, and mortality of stem rot disease, which was caused by a highly virulent strain of *Sclerotium rolfsii* (SrPWp) in groundnut plants grown in field conditions. Analysis of the data presented in Tables revealed a gradual increase in disease severity, incidence, and mortality of groundnut plants over time following inoculation.

Disease severity
The efficacy of treatments on the severity of stem rot disease in groundnut induced by S. rolfsii was investigated, and the results revealed that at location-I, treatment T10, which consisted of *Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin, exhibited the least disease severity of 13.23%. This was followed by treatment T3, which involved azoxystrobin at a reduced rate, with a disease severity of 14.74%, and treatment T8, which included *Trichoderma viride* as ST + SA + reduced rate of azoxystrobin, with a disease severity of 17.02% at 15 dpi (days post pathogen inoculation). At 30 dpi, the treatment T10 demonstrated the least disease severity of 28.47%, followed by treatment T8 with 33.54%. This trend was consistently observed at 45, 60, and 75 dpi. In total, the treatment T10 recorded a significantly lowest mean disease severity of 35.51%, with treatment T8 (40.16%) and treatment T9 (43.36%) being comparable to each other.

Similarly, a comparable trend was observed at location-II, where a significantly lower average disease severity was noted with the implementation of treatment T10 (consisting of *Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (11.21). This was followed by treatment T3 (azoxystrobin at a reduced rate) (12.68) and treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (15.26) at 15 dpi (days post pathogen inoculation). The treatment T10 (26.76%) displayed the least disease severity at 30 dpi, followed by treatment T8 (28.98%). A similar pattern was observed at 45, 60, and 75 dpi. In total, treatment T10 (consisting of *Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded a significantly lower mean disease severity of 32.77%. This was followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (36.53) and treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (39.51), which were found to be statistically equivalent to each other.
Interestingly, a similar trend was observed in the combined data, where the treatment T10 (consisting of *Trichoderma viride* and *Bacillus cereus* as seed treatment, soil amendment, and reduced rate of azoxystrobin) was identified as the most effective, followed by treatment T8 (which included *Trichoderma viride* as seed treatment, soil amendment, and reduced rate of azoxystrobin) and treatment T9 (comprising of *Bacillus cereus* as seed treatment, soil amendment, and reduced rate of azoxystrobin) (Table-1).

Disease incidence

A similar pattern was observed in the effectiveness of treatments on the occurrence of stem rot disease in groundnut caused by S. rolfsii under field conditions. At location-I, the treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) exhibited the significantly lowest disease occurrence of 21.45 percent. Additionally, treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (25.45%) was identified as the next best treatment (37.86%) and was comparable to treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (27.56%) at 15 dpi (days post pathogen inoculation). A similar pattern was observed at 30, 45, 60, and 75 dpi. Overall, the treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) displayed a significantly lower average disease occurrence of 32.55 percent, followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) with a disease occurrence of 37.86 percent, which was comparable to treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (39.47%).
Likewise, a similar trend was observed at location-II (Rajendranagar), where a significantly lower average disease incidence of 30.26 percent was recorded with treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin). This was followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) with a disease incidence of 38.37 percent and treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) with a disease incidence of 39.19 percent. Furthermore, a similar trend was observed in the combined data, where treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was found to be the most effective. Additionally, treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) was found to be the next best treatment, which was on par with treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (Table-2).
At location-II, in the treatment labeled T10 where *Trichoderma viride* and *Bacillus cereus* were used as ST + SA + reduced rate of azoxystrobin, there was a 7.01 percent augmentation in the occurrence of the disease at 30 days post-infection (dpi) when compared to 45 dpi (6.73%), 60 dpi (3.93%), and 75 dpi (1.55%). In the treatment labeled T9 where *Bacillus cereus* was used as ST + SA + reduced rate of azoxystrobin, there was a 9.22 percent increase in the incidence of the disease at 30 dpi when compared to 45 dpi (5.89%), 60 dpi (2.62%), and 75 dpi (0.46%). In the treatment labeled T8 where *Trichoderma viride* was used as ST + SA + reduced rate of azoxystrobin, there was an 8.66 percent rise in the occurrence of the disease at 30 dpi when compared to 45 dpi (5.89%), 60 dpi (3.57%), and 75 dpi (0.91%). In the treatment labeled T2, there was a 14.87 percent increase in the incidence of the disease at 30 dpi when compared to 45 dpi (8.19%), 60 dpi (8.1%), and 75 dpi (2.32%). However, at 45 dpi, there was a sudden escalation in the severity of the disease from 35.25 to 50.12. No severe and drastic surge in the incidence of the disease was observed in the other treatments.

Mortality

All the treatments were effective in reducing the mortality of groundnut plants although they differed in per cent mortality among the treatments. It was observed that with the increase in age of the crop there was a gradual increase in mortality from 30 days after inoculation to 75 days after inoculation although the per cent mortality was less from 60 to 75 days after inoculation when compared to inoculated control in all the treatments. The treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was very effective in reducing the mortality followed by T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) when compared to inoculated control. Both these treatments were more effective than with the seed treatment and foliar application of fungicide azoxystrobin in reducing the mortality.

The treatments have shown significant differences in controlling the mortality in groundnut plants induced by *S. rolfsii* under field conditions. At location-I, mortality was not observed at 15 dpi in all the treatments. Further, at 30 dpi treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded significantly least mortality (6.46%). Whereas treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (8.24) was found to be next best treatment which was at par with treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (10.42) and same trend was noted at 45, 60 and 75 dpi. In total, treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded significantly least mean mortality of 10.02 per cent. Treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (13.87) was found to be next best treatment and was at par with T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (16.19).

Interestingly, similar trend was recorded at location-II and in pooled data wherein the treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was found to be most effective in controlling the mortality induced by *S. rolfsii* under field conditions. Further, treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) was found to be next best treatment which was at par with treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (Table-3).

Growth promoting traits

The treatments have contributed significantly to several growth promoting traits in groundnut under field conditions. At location-I, treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded significantly higher germination percentage 78.42 followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) with 75.34 per cent germination and was at par with treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (74.92%). Similar observations were noted with respect to plant height, wherein treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was significantly superior (48.23 cm). Treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) was found to be next best treatment with 45.76 cm and was at par with treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (44.80 cm). Likewise, different treatments in the study did not differ significantly with respect to the oil and protein content and was ranged from 41.75 to 47.78 per cent and 21.79 to 24.96 per cent respectively, indicating no deleterious effect of these treatments on oil and protein content of groundnut under field conditions. Interestingly, the similar trend was observed at location-II and in the pooled data (Table-4). However the oil content and protein content were non significant in all the treatments when compared to inoculated control.

Yield and yield related traits

All the treatments had positive effect on yield and yield related traits under field conditions. At location-I (ICRISAT), treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded significantly highest number of pods per plant (29.74) followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (26.63) and treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (27.16) and were on par with each other. With regard to 100 kernel weight, treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (40.75 g) performed significantly superior followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (38.42 g). Likewise, significantly highest shelling percentage was noted in treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) (74.25) followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (70.83). Similar observations were recorded with respect to pod yield, wherein treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was significantly superior (2430.42 kg/ha) followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (2245.63 kg/ha). Interestingly, treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded the highest B:C ratio of (2.86) followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) (2.74). Further, similar trend was noted at location-II and in pooled data (Table-5).

Hence, from the above results it was found that, treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was found significantly most effective in controlling stem rot disease of groundnut under field conditions and was at par with treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) followed by T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin)

In the present study, application of mixture of treatments through seed treatment followed by soil application and chemical treatment had effectively checked the disease in glasshouse and field conditions.

The results are in line with the findings of Dubey *et al*., 2015 who demonstrated the combined use of *P. fluorescens*, *Mesorhizobium cicero* and *T. harzianum* with the fungicide vitavax (carboxin and thiram) in chickpea contributed to the highest seed germination, grain yield and the lowest wilt incidence (incited by *F. oxysporum*) in pot and field experiments.

Moreover, Jambhulkar *et al*., 2018 reported that the combination of *T. harzianum*, *P. fluorescens* and carbendazim was more effective against *Magnaporthe oryzae* in comparison to their individual application in field experiments of rice. In addition, efficacy of combination of different methods of applying bioagents was reported by Vidhyasekaran *et al.* (1997), Vidhyasekaran and Muthamilan (1999), Meena *et al.* (2000), Nandakumar *et al.* (2001) and Saravanakumar (2006) in control of various soil borne fungal pathogens.

CONCLUSION

During field and glasshouse studies, the efficacy of talc formulations containing the bioagents *Trichoderma viride* and *Bacillus cereus*, both individually and in combination, for the management of stem rot disease were evaluated at two locations, Patancheru and Rajendranagar. The bioagents *Trichoderma viride*, *Bacillus cereus* and fungicide azoxystrobin performed exceptionally well. The treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) was found most effective in controlling stem rot of groundnut followed by treatment T8 (*Trichoderma viride* as ST + SA + reduced rate of azoxystrobin) and treatment T9 (*Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) under glasshouse and field conditions. The treatment T10 (*Trichoderma viride* and *Bacillus cereus* as ST + SA + reduced rate of azoxystrobin) recorded substantial amount of growth and yield attributing parameters in groundnut under field conditions.

REFERENCES

1. Abada, M. and Ahmad, M. (2014). A comparative study for the effect of green tea extract and some antioxidants on Thompson seedless grapevines. International Journal of Plant and Soil Science. 3(10): 1333-1342.
2. Directorate of Economics and Statistics. (2019). *In*; Agricultural Statistics at a Glance. Directorate of Economics and Statistics, pp, 110.
3. Dubey, S. C., Singh, V., Priyanka, K., Upadhyay, B. K., & Singh, B. (2015). Combined application of fungal and bacterial bio-agents, together with fungicide and *Mesorhizobium* for integrated management of Fusarium wilt of chickpea. *Biological Control*, 60, 413–424.
4. FAOSTAT. 2019. Food and Agricultural Organization statistics database (Faostat). *<http://faostat.fao.org/>*.
5. INDIASTAT. (2019). Socio-economic statistical information about India. www.INDIASTAT. com.
6. Ingale and Patale. (2019). Antagonistic potential of Trichoderma sp. against fungal pathogens of pulses. A Quarterly Journal of Life Sciences. 16(4): 251-252.
7. Jambhulkar, P. P., Sharma, P., Manokaran, R., Lakshman, D.K., Rokadia, P., & Jambhulkar, N. (2018). Assessing synergism of combined applications of *Trichoderma harzianum* and *Pseudomonas fluorescens* to control blast and bacterial leaf blight of rice. *European Journal of Plant Pathology*, 152:747–757.
8. Jangir, M., Sharma, S. and Satyawati, S. (2020). Synergistic effect of oilseed cake and biocontrol agent in the suppression of Fusarium wilt in *Solanum lycopersicum*. *Brazilian Journal of Microbiology*. 51: 1929-1939.
9. Javaid, A., Khan, A.I.H. and Shoaib (2018). Management of charcoal rot of mungbean by two Trichoderma species and dry biomass of Coronopus didymus. Planta Danin. 36: 1-8.
10. Karthikeyan, V., Sankaralingam, A. and Nakkeeran, S. (2006). Management of groundnut root rot with biocontrol agents and organic amendments. Archives of Phytopathology and Plant Protection. 39(3): 215-223.

11. Kwon and Park (2002). Stem rot of tomato caused by *Sclerotium rolfsii* in Korea. Microbiology. 30(4): 244-246.
12. Le, C. N., Mendes, R., Kruijt, M., & Raaijmakers, J. M. (2012). Genetic and phenotypic diversity of *Sclerotium rolfsii* in groundnut fields in Central Vietnam. *Plant Disease*, 96, 389-397.
13. Meena, B., Radhajeyalakshmi, R., Marimuthu, T., Vidhyasekaran, P., Doraiswamy, S., & Velazhahan, R. (2000). Induction of pathogenesis-related proteins, phenolics and phenylalanine ammonia-lyase in groundnut by *Pseudomonas fluorescens*. *Journal of Plant Diseases and Protection*, 107, 514-527.
14. Mehan, V.K. and McDonald, D. (1990). Some important diseases of groundnut-sources of resistance and their utilization in crop improvement. Paper presented at the in Country Training Course on Legumes Production. July 9-17, Sri Lanka. limited distribution.
15. Moosa, A., Sahi, ST., Haq, IU., Farzand, A., Khan, SA., Javaid, K. (2017). Antagonistic potential of Trichoderma isolates and manures against Fusarium wilt of tomato. International Journal of Vegetable Science. 23(3): 207-218.
16. Nandakumar, R., Viswanathan, R., Babu, S., Sheela, J., Raguchander, T., & Samiyappan, R.(2001). A new bioformulation containing plant growth promoting rhizobacterial mixture for the management of sheath blight and enhanced grain yield in rice. *Biocontrol*, 46, 493-510.
17. Saravanakumar. (2006). Molecular and biochemical marker assisted selection of fluorescent pseudomonad strains for ecofriendly management of leaf folder insect and sheath rot disease in rice. *Ph.D. Thesis*, Tamil Nadu Agricultural University, Coimbatore, p. 275.
18. Sharma, K.S. and Prasad. L. (2018). Bioactivity of *Trichoderma asperellum* against *Colletotri chum asianum* and *Sclerotinia sclerotiorum*. *Pest Research* Journal. 30: 251-255.
19. Shokes, F.M., Rozalski, K., Gorbet, D.W., Brenneman, T.B., & Berger, D.A. (1996). Techniques for inoculation of peanut with *Sclerotium rolfsii* in the green house and field. *Peanut Science*, 23(1),124-128.
20. Sohaliya, N.N., Pathak, D.M., Pandya, J.R. (2019). In vitro antagonistic activity of Trichoderma species against important soil borne pathogens. International Journal of Plant Protection. 12: 127-131.
21. Sturgeon, R.V.J. (1986). Peanut disease loss estimates for major peanut producing states in the United States for 1984 and 198.5. Proceedings of American Peanut Science (2003) 30: 128- 133 Peanut Research Education Society. 18: 24-25.
22. Tayyab, M., Islam, W., Lee, C.G., Pang, Z., Khalil, F., Lin, S., Lin, W. and Zhang, H. (2019). Short-term effects of different organic amendments on soil fungal composition. Sustainability. 11(198): 1-13.
23. Vengadesh Kumar, L., Kalaiselvi, M., Meera, T., Sanjayghandi, S., Udhayakumar, R., Rajamohan, K. and Sudhasha, S. (2019). Effect of neem compared with *Pseudomonas fluorescens* on the management of cowpea root rot disease. *Journal of Biopesticides*. 12(2): 232-238.
24. Vidhyasekaran, P., & Muthamilan, M. (1999). Evaluation of powder formulation of *Pseudomonas fluorescens* Pf1 for control of rice sheath blight. *Biocontrol Science and Technology*, 9, 67-74.
25. Vidhyasekaran, P., Rabindran, R., Muthamilan, M., Nayar, K., Rajappan, K., Subramanian, N., & Vasumathi, K. (1997). Development of powder formulation of *Pseudomonasfluorescens* for control of rice blast. *Plant Pathology*, 46, 291-297.
26. Xu, Z. Y. (2008). Disease, pests, weeds and mice of peanut (in Chinese). Beijing: China agriculture press.

Table 1. Effect of seed treatment and soil application of *Trichoderma viride*, *Bacillus cereus* and fungicide and their combinations on stem rot severity in groundnut under field conditions

Treatment	Disease severity (%)																	
	Location I						Location II						Pooled					
	15 dpi*	30 dpi	45 dpi	60 dpi	75 dpi	Mean	15 dpi	30 dpi	45 dpi	60 dpi	75 dpi	Mean	15 dpi	30 dpi	45 dpi	60 dpi	75 dpi	Mean
T1	3.15 (10.21)**	8.47 (16.89)	20.89 (27.18)	25.41 (30.26)	28.55 (32.29)	17.29	2.74 (9.52)	6.32 (14.55)	18.13 (25.19)	23.46 (28.94)	26.31 (30.85)	15.39	2.94 (9.87)	7.39 (15.77)	19.51 (26.21)	24.43 (29.62)	27.43 (31.58)	16.34
T2	31.36 (34.02)	59.12 (50.26)	72.53 (58.42)	74.23 (59.97)	77.63 (62.14)	62.97	25.64 (30.40)	52.76 (46.21)	66.25 (54.60)	67.63 (55.61)	69.71 (56.64)	56.39	28.5 (32.27)	55.62 (48.23)	69.39 (56.41)	70.93 (57.37)	73.67 (59.13)	59.68
T3	14.74 (22.57)	42.31 (40.55)	52.87 (46.648)	57.94 (49.57)	60.48 (51.06)	45.66	12.68 (20.90)	38.87 (38.22)	48.45 (44.35)	55.43 (48.44)	58.86 (49.89)	42.85	13.74 (21.76)	40.31 (39.41)	50.87 (45.50)	56.94 (48.99)	59.48 (50.46)	44.25
T4	16.42 (23.84)	40.21 (39.35	54.42 (47.53)	60.85 (51.26)	64.64 (53.63)	47.30	16.13 (22.28)	36.64 (36.90)	52.76 (46.39)	58.34 (50.13)	62.32 (52.33)	45.23	15.42 (23.12)	38.21 (38.18)	53.42 (46.96)	59.85 (50.68)	63..64 (58.34)	46.26
T5	17.54 (24.75)	42.89 (40.90)	55.24 (48.02)	61.57 (51.69)	66.48 (54.66)	48.74	16.61 (23.99)	39.38 (39.15)	54.34 (47.44)	59.98 (50.59)	61.65 (51.66)	46.39	17.04 (24.38)	41.39 (40.04)	54.74 (47.72)	60.57 (51.10)	63.98 (53.12)	47.56
T6	18.48 (25.43)	48.04 (43.87)	61.41 (51.63)	66.39 (54.56)	68.12 (55.62)	52.48	15.34 (23.16)	45.43 (42.15)	56.94 (48.70)	60.23 (51.01)	64.20 (53.34)	48.42	16.98 (24.33)	46.54 (43.02)	58.91 (50.13)	63.39 (52.77)	66.12 (54.40)	50.45
T7	21.46 (27.54)	47.49 (43.55)	64.36 (53.35)	67.26 (55.14)	73.03 (58.92)	54.72	18.79 (25.38)	44.31 (41.83)	61.26 (51.58)	63.49 (52.69)	68.74 (55.79)	51.31	19.96 (26.54)	45.99 (42.70)	62.86 (52.45)	65.26 (53.89)	70.53 (57.12)	53.01
T8	17.02 (24.36)	33.54 (35.36)	45.36 (42.30)	50.14 (45.08)	54.78 (47.74)	40.16	15.26 (22.80)	28.98 (32.25)	41.84 (40.00)	45.23 (42.20)	51.38 (46.02)	36.53	16.02 (23.59)	31.04 (33.86)	43.48 (41.25)	47.64 (43.65)	53.28 (46.88)	38.34
T9	19.74 (26.35)	36.86 (37.37)	47.37 (43.49)	54.78 (47.76)	58.08 (49.72)	43.36	17.98 (25.07)	33.81 (35.56)	42.39 (40.60)	51.29 (46.20)	52.09 (46.21)	39.51	18.86 (25.74)	35.36 (36.49)	44.88 (42.06)	53.28 (46.88)	55.08 (47.92)	41.43
T10	13.23 (21.32)	28.47 (32.19)	39.38 (38.86)	47.26 (43.42)	49.23 (44.55)	35.51	11.21 (19.57)	26.76 (30.94)	34.21 (35.87)	45.37 (42.28)	46.34 (42.82)	32.77	12.23 (20.47)	27.47 (31.61)	36.88 (37.39)	46.26 (42.86)	47.73 (43.70)	34.14
Mean	17.31 (24.59)	38.74 (38.49)	51.38 (45.79)	56.58 (48.78)	60.10 (50.83)	-	15.02 (22.80)	35.12 (36.34)	47.58 (43.61)	53.12 (46.79)	56.08 (48.49)	-	16.16 (23.70)	36.93 (37.42)	49.49 (44.71)	54.85 (47.78)	57.47 (49.30)	-

Factors	Location I			Location II			Pooled		
	CD (0.05)	S.Em.±	CV (%)	CD (0.05)	S.Em.±	CV (%)	CD (0.05)	S.Em.±	CV (%)
Treatments	1.60	0.57		1.66	0.59		1.26	0.38	
dpi	2.26	0.80	7.53	2.35	0.83	8.24	1.62	0.58	7.88
Interaction	5.07	1.80		5.26	1.87		3.63	1.30	

***dpi** – days post pathogen inoculation **Figures in the parenthesis are arc sine transformed values

Table 2. Effect of seed treatment and soil application of *Trichoderma viride*, *Bacillus cereus* and fungicide and their combinations on stem rot incidence in groundnut under field conditions

Treatment	Disease incidence (%)																	
	Location I						Location II						Pooled					
	15 dpi*	30 dpi	45 dpi	60 dpi	75 dpi	Mean	15 dpi	30 dpi	45 dpi	60 dpi	75 dpi	Mean	15 dpi	30 dpi	45 dpi	60 dpi	75 dpi	Mean
T1	5.22 (13.19)**	10.31 (18.72)	15.63 (23.27)	17.21 (24.50)	18.65 (25.56)	13.40	3.02 (10.00)	9.64 (18.08)	12.14 (20.36)	14.58 (22.42)	15.31 (22.98)	10.93	4.12 (11.71)	9.97 (18.41)	13.88 (21.87)	15.89 (23.49)	16.98 (24.33)	12.16
T2	39.04 (38.66)	54.70 (47.69)	61.22 (51.48)	70.56 (57.70)	72.37 (58.31)	59.57	35.25 (36.41)	50.12 (45.06)	58.31 (49.80)	66.41 (54.58)	68.73 (56.16)	55.76	37.14 (37.55)	52.41 (46.38)	59.76 (50.63)	68.48 (55.85)	70.55 (57.13)	57.66
T3	29.28 (32.75)	37.84 (37.94)	44.96 (42.09)	48.12 (43.92)	50.14 (45.07)	42.06	27.36 (31.51)	35.48 (36.54)	42.98 (40.94)	46.47 (42.94)	49.88 (44.93)	40.43	28.32 (32.15)	36.66 (37.26)	43.97 (41.54)	47.29 (43.35)	50.01 (45.01)	41.24
T4	32.23 (34.58)	43.13 (41.05)	47.25 (43.41)	51.32 (45.75)	53.69 (47.12)	45.54	30.21 (33.32)	42.58 (40.73)	45.31 (42.29)	48.27 (44.00)	50.36 (45.20)	43.34	31.22 (33.97)	42.85 (40.89)	46.28 (42.87)	49.79 (44.88)	52.02 (46.16)	44.44
T5	33.67	41.35	48.36	53.69	55.33	46.48	31.34	38.23	46.87	51.78	53.47	44.33	32.50	39.79	47.61	52.73	54.40	45.40

	(35.45)	(40.01)	(44.05)	(47.11)	(48.07)		(34.02)	(38.18)	(43.19)	(46.02)	(47.01)		(34.76)	(39.11)	(43.63)	(46.56)	(47.52)	
T6	36.78 (37.33)	45.60 (42.47)	51.32 (45.75)	56.42 (48.72)	58.87 (50.15)	49.79	36.12 (36.93)	42.61 (40.74)	49.54 (44.73)	53.21 (46.85)	56.34 (48.64)	47.56	36.45 (37.14)	44.10 (41.61)	50.43 (45.25)	54.81 (47.76)	57.60 (49.37)	48.67
T7	38.26 (38.19)	45.82 (42.58)	53.63 (47.08)	58.96 (50.16)	60.23 (50.90)	51.38	36.41 (37.09)	44.87 (42.05)	51.36 (45.78)	56.45 (48.71)	58.79 (50.07)	49.57	37.33 (37.66)	45.34 (42.33)	52.49 (46.93)	57.70 (49.43)	59.51 (50.48)	50.47
T8	25.45 (30.29)	34.41 (35.91)	40.83 (39.71)	43.27 (41.13)	45.34 (42.32)	37.8 6	26.23 (30.80)	34.89 (36.20)	40.78 (39.68)	44.35 (41.75)	45.62 (42.48)	38.37	25.84 (30.55)	34.65 (36.06)	40.80 (39.70)	43.81 (41.44)	45.48 (42.41)	38.11
T9	27.56 (31.63)	37.10 (37.515)	41.86 (40.31)	44.39 (41.74)	46.45 (42.91)	39.47	27.14 (31.38)	36.36 (37.07)	42.25 (40.52)	44.87 (42.05)	45.33 (42.31)	39.19	27.35 (31.53)	36.73 (37.30)	42.05 (40.43)	44.63 (41.92)	45.89 (42.64)	39.33
T10	21.45 (27.58)	28.54 (32.26)	34.24 (35.80)	38.31 (38.23)	40.24 (39.36)	32.55	18.74 (25.64)	25.75 (30.45)	32.48 (34.72)	36.41 (37.07)	37.96 (38.02)	30.26	20.09 (26.63)	27.14 (31.40)	33.36 (35.28)	37.36 (37.68)	39.10 (38.70)	31.40
Mean	28.88 (32.51)	37.88 (37.99)	49.93 (41.51)	48.22 (43.98)	50.13 (45.07)	-	27.18 (31.42)	36.05 (36.90)	42.20 (40.51)	46.28 (42.87)	48.17 (43.95)	-	28.03 (31.97)	36.96 (37.44)	43.06 (41.01)	47.24 (43.42)	49.15 (44.51)	-

Factors	Location I			Location II			Pooled		
	CD (0.05)	S.Em.±	CV (%)	CD (0.05)	S.Em.±	CV (%)	CD (0.05)	S.Em.±	CV (%)
Treatments	1.41	0.50	7.90	1.29	0.46	9.54	1.56	0.47	7.56
Dpi	1.99	0.71		1.83	0.65		1.31	0.47	
Interaction	4.46	1.59		4.11	1.46		2.94	1.05	

*__dpi__ – days post pathogen inoculation **Figures in the parenthesis are arc sine transformed values

Table 3. Effect of seed treatment and soil application of *Trichoderma viride*, *Bacillus cereus* and fungicide and their combinations on mortality due to stem rot of groundnut under field conditions

Treatment	**Mortality (%)**																	
	Location I						**Location II**						**Pooled**					
	15 dpi*	**30 dpi**	**45 dpi**	**60 dpi**	**75 dpi**	**Mean**	**15 dpi**	**30 dpi**	**45 dpi**	**60 dpi**	**75 dpi**	**Mean**	**15 dpi**	**30 dpi**	**45 dpi**	**60 dpi**	**75 dpi**	**Mean**
T1	0.00 (0.00)	2.30 (8.72)**	5.74 (13.85)	10.78 (19.15)	11.02 (19.38)	5.96	0.00 (0.00)	1.92 (7.95)	4.84 (12.70)	9.36 (17.81)	10.42 (18.83)	5.30	0.00 (0.00)	2.11 (8.35)	5.29 (13.30)	10.07 (18.50)	10.72 (19.11)	5.63
T2	0.00 (0.00)	20.36 (26.81)	41.58 (40.14)	52.24 (46.29)	53.41 (46.96)	33.51	0.00 (0.00)	18.74 (25.64)	38.24 (38.18)	50.78 (45.44)	51.12 (45.66)	31.77	0.00 (0.00)	19.55 (26.24)	39.91 (39.18)	51.31 (45.75)	52.26 (46.30)	32.64
T3	0.00 (0.00)	10.56 (18.94)	19.32 (26.02)	26.34 (30.84)	27.86 (31.85)	16.81	0.00 (0.00)	8.41 (16.85)	17.63 (24.79)	24.42 (29.61)	25.24 (30.15)	15.14	0.00 (0.00)	9.48 (17.93)	18.47 (25.45)	25.38 (30.25)	26.55 (31.02)	15.97
T4	0.00 (0.00)	11.75 (20.03)	25.44 (30.28)	32.68 (34.84)	34.21 (35.79)	20.81	0.00 (0.00)	9.23 (17.63)	23.03 (28.65)	30.47 (33.49)	32.95 (35.02)	19.13	0.00 (0.00)	10.49 (18.90)	24.23 (29.49)	31.57 (34.19)	33.58 (35.41)	19.97
T5	0.00 (0.00)	13.78 (21.77)	27.40 (31.55)	35.47 (36.54)	37.35 (37.66)	22.80	0.00 (0.00)	12.74 (20.90)	23.48 (28.97)	33.12 (35.13)	36.30 (37.04)	21.12	0.00 (0.00)	13.26 (21.35)	25.44 (30.29)	34.29 (35.84)	36.82 (37.36)	21.96
T6	0.00 (0.00)	14.82 (22.59)	29.26 (32.72)	36.89 (37.36)	37.42 (37.66)	23.67	0.00 (0.00)	13.41 (21.47)	27.78 (31.80)	34.27 (35.79)	35.08 (36.31)	22.10	0.00 (0.00)	14.11 (22.06)	28.52 (32.28)	35.58 (36.62)	36.25 (37.02)	22.88
T7	0.00 (0.00)	16.78 (24.13)	31.39 (34.07)	39.48 (38.89)	40.10 (39.28)	25.55	0.00 (0.00)	15.37 (23.07)	28.45 (32.18)	36.32 (37.06)	37.14 (37.53)	23.45	0.00 (0.00)	16.07 (23.63)	29.92 (33.16)	37.90 (38.00)	38.62 (38.42)	24.50
T8	0.00 (0.00)	8.24 (16.65)	17.87 (24.94)	20.36 (26.81)	22.88 (28.54)	13.87	0.00 (0.00)	6.39 (14.63)	15.78 (23.40)	17.20 (24.48)	19.34 (26.08)	11.74	0.00 (0.00)	7.31 (15.69)	16.82 (24.21)	18.78 (25.68)	21.11 (27.35)	12.80
T9	0.00 (0.00)	10.42 (18.83)	20.78 (27.11)	24.31 (29.47)	25.48 (30.31)	16.19	0.00 (0.00)	9.10 (17.55)	18.56 (25.49)	23.58 (29.03)	23.40 (28.84)	14.92	0.00 (0.00)	9.76 (18.20)	19.67 (26.33)	23.94 (29.29)	24.44 (29.63)	15.55
T10	0.00 (0.00)	6.46 (14.70)	11.36 (19.67)	15.48 (23.14)	16.80 (24.16)	10.02	0.00 (0.00)	5.32 (13.31)	9.85 (18.28)	13.42 (21.48)	14.28 (22.17)	8.57	0.00 (0.00)	5.89 (14.05)	10.60 (19.00)	14.45 (22.34)	15.54 (23.22)	9.29
Mean	0.00 (0.00)	11.54 (19.86)	23.01 (28.67)	29.40 (32.83)	30.65 (33.62)	-	0.00 (0.00)	10.06 (18.50)	20.76 (27.11)	27.29 (31.50)	28.52 (32.28)	-	0.00 (0.00)	10.80 (19.19)	21.88 (27.89)	28.32 (32.16)	29.58 (32.95)	-

Factors	Location I			Location II			Pooled		
	CD (0.05)	SEm±	CV (%)	CD (0.05)	SEm±	CV (%)	CD (0.05)	SEm±	CV (%)
Treatments	1.10	0.39	9.55	0.84	0.29	7.66	0.76	0.23	8.74
dpi	1.56	0.55		1.18	0.42		0.97	0.35	
Interaction	3.49	1.24		2.66	0.94		2.19	0.78	

*__dpi__ – days post pathogen inoculation **Figures in the parenthesis are arc sine transformed values

Table 4. Effect of seed treatment and soil application of *Trichoderma viride*, *Bacillus cereus* and fungicide and their combinations on growth parameters of groundnut under field conditions

Treatments	**Location I**				**Location II**				**Pooled**			
	Germ (%)	**Plant height (cm)**	**Oil content (%)**	**Protein content (%)**	**Germ (%)**	**Plant height (cm)**	**Oil content (%)**	**Protein content (%)**	**Germ (%)**	**Plant height (cm)**	**Oil content (%)**	**Protein content (%)**
T1	71.42	40.99	42.49	22.48	61.25	36.47	40.28	20.28	66.335	38.73	41.385	21.38
T2	70.42	39.23	41.75	21.79	60.00	34.26	39.49	18.34	65.21	36.745	40.62	20.065
T3	74.33	44.03	43.15	22.75	62.75	38.92	40.37	20.76	68.54	41.475	41.76	21.755
T4	71.96	41.80	44.36	23.73	59.30	39.29	41.29	20.43	65.63	40.545	42.825	22.08
T5	71.84	41.13	44.79	23.34	60.25	40.72	41.16	21.46	66.045	40.925	42.975	22.4
T6	73.23	43.96	45.84	24.46	59.30	41.38	42.48	22.37	66.265	42.67	44.16	23.415
T7	72.20	42.68	45.43	24.75	61.92	38.85	43.28	21.26	67.06	40.765	44.355	23.005
T8	75.34	45.76	46.99	23.76	65.23	42.42	43.74	22.49	70.285	44.09	45.365	23.125
T9	74.92	44.80	46.22	22.78	63.98	40.38	43.41	22.90	69.45	42.59	44.815	22.84
T10	78.42	48.23	47.78	24.96	68.12	45.21	44.46	23.48	73.27	46.72	46.12	24.22
Mean	73.408	43.26	44.88	23.48	62.21	39.79	41.99	21.37	67.80	41.52	43.438	22.42
CD (0.05)	5.40	6.32	(NS)	(NS)	7.40	6.61	(NS)	(NS)	4.20	4.25	(NS)	(NS)
S.Em.±	1.32	1.55	2.45	1.63	1.81	1.62	2.48	1.03	1.47	1.49	2.21	1.27
CV (%)	7.13	8.21	9.48	12.07	8.06	7.07	10.24	8.39	7.06	8.24	10.24	8.39

Table 5. Effect of seed treatment and soil application of *Trichoderma viride*, *Bacillus cereus* and fungicide and their combinations on yield parameters of groundnut under field conditions

Treatments	**Location I**					**Location II**					**Pooled**				
	Pods/plant	**100 kernel weight (g)**	**Shelling (%)**	**Pod yield (kg/ha)**	**B : C ratio**	**Pods/plant**	**100 kernel weight (g)**	**Shelling (%)**	**Pod yield (kg/ha)**	**B : C ratio**	**Pods/plant**	**100 kernel weight (g)**	**Shelling (%)**	**Pod yield (kg/ha)**	**B : C ratio**
T1	22.62	34.84	64.30	1729.48	1.94	25.34	36.61	66.68	1942.86	2.04	23.98	35.72	65.49	1836.17	1.99
T2	20.43	32.96	59.36	1534.82	1.86	23.79	35.38	62.31	1681.34	1.98	22.11	34.17	60.83	1608.08	1.92
T3	25.82	36.83	68.96	1988.26	2.15	28.80	40.49	69.94	2296.83	2.41	27.31	38.66	69.45	2142.54	2.28
T4	23.73	35.85	65.18	1834.25	2.02	26.78	38.74	67.20	2084.24	2.24	25.25	37.29	66.19	1959.24	2.13
T5	22.49	34.12	64.58	1708.44	1.91	26.34	38.20	66.95	1932.62	2.06	24.415	36.16	65.76	1820.53	1.98
T6	25.30	36.46	67.89	2074.23	2.48	28.20	40.39	69.30	2238.30	2.59	26.75	38.42	68.59	2156.26	2.53
T7	24.58	36.20	65.13	1912.48	2.05	27.49	39.24	68.12	2127.64	2.34	26.03	37.72	66.62	2020.06	2.19
T8	26.63	38.42	70. 83	2245.63	2.74	29.78	42.39	73. 46	2482.87	2.85	28.20	40.40	72.14	2364.25	2.79
T9	27.16	37.65	68.14	2123.94	2.58	28.94	40.23	71.39	2426.32	2.76	28.05	38.94	69.76	2275.13	2.67
T10	29.74	40.75	74.25	2430.42	2.86	31.74	45.03	76.62	2684.30	3.02	30.74	42.89	75.43	2557.36	2.94
Mean	24.85	36.40	66.42	1958.19	2.25	27.72	39.67	68.72	2189.73	2.42	26.28	38.03	68.026	2073.96	2.34
CD (0.05)	6.00	4.90	9.63	558.31	-	5.93	7.30	8.76	514.58	-	3.76	3.96	5.80	119.12	-
S.Em.±	1.47	1.20	2.36	137.17	-	1.45	1.79	2.15	126.43	-	1.32	1.39	2.03	339.31	-
CV (%)	10.28	7.73	7.12	12.13	-	9.11	7.79	7.39	10.00	-	9.06	7.80	7.14	12.13	-