

THESIS ABSTRACTS
2017

Plant Pathology

Compiled By

Dr. Santosh D. Kadam

Co-Compiler

Dr. Vandana S. Jadhav
Mr. Bhagwan G. Kamble
Mr. Mohankumar Zore



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VIDYAPEETH, PARBHANI**

Title - **Epidemiology and management of yellow vein mosaic of okra**

Researcher - Bhukan, Amol Balu

Research Guide - Mulekar, V.G.

Department - Plant Pathology

Subject - Plant Pathology

Degree - M.Sc

Thesis No. - 1719

Krishikosh link - <http://krishikosh.egranth.ac.in/handle/1/5810033245>

Abstract -

Okra (*Abelmoschus esculentus* L. Monech), commonly known as “Bhendi” or “Lady’s finger”, belongs to family Malvaceae. It is an important vegetable crop grown all over the country in rainy, spring and summer season. The okra, known as king of summer vegetable is cultivated in the tropics and subtropics during warm season. The yield loss caused by diseases of okra is to the tune of 95.7 per cent (Pun and Sabitha, 2005). The disease was transmissible by whitefly *Bemisia tabaci* in persistence manner.

Present investigation on the yellow vein mosaic disease were carried out during *Kharif* , 2016 with the objective viz., 1.To survey the yellow vein mosaic disease incidence on farmer’s field in Parbhani district 2.To study the epidemiology of yellow vein mosaic of okra 3.Management of yellow vein mosaic of okra by insect vector control with insecticides, plant extracts and bioagents at Department of Plant Pathology, College of Agriculture Parbhani.

To know occurrence and distribution of yellow vein mosaic disease of okra Parbhani district a roving survey in the month of August-September in kharif season was conducted in all tahasils of Parbhani district. The yellow vein mosaic of okra was found prevalent disease throught Parbhani district. In was also found to vary from cultivar to cultivar and location to location. The yellow vein mosaic disease incidence ranged from 12.50 to 20.50 per cent.

The effect of climatic factors indicated that the occurrence of the vector on okra was throughout the season in *kharif* i.e from August to November. However vector population level were higher (3.99/ leaf) during October than in rest month in *kharif*. The correlation between max. temperature with whitefly population was positively significant and

min. temperature and relative humidity (a.m. and p.m.) was negatively significant with whitefly population.

The effect of different spraying of insecticide imidacloprid, acetamiprid, difenthiuron, bioagents *Verticillium*, *Pseudomonas* and plant extracts azadirachtin, bougainvillea on infection rate (r), vector population dynamics, disease incidence and yield of okra was studied. The spraying with imidacloprid 17.8 EC recorded lowest whitefly population (0.99 whitefly/leaf) and less disease incidence (13.30 %) and more yield (4756.52 kg/ha) than rest of the treatment.

Title	- Studies on pod blight of soybean in parbhani district (Schw.)
Researcher	- Kolekar, B.U.
Research Guide	- Badgujar, S.L.
Department	- Plant Pathology
Subject	- Plant Pathology
Degree	- M.Sc
Thesis No.	- 1721
Krishikosh link	- http://krishikosh.egranth.ac.in/handle/1/5810033247
Abstract	-

Pod blight disease caused by *Colletotrichum truncatum* (Schw.) Andrus and Moore has been reported as major constraint in the successful cultivation of soybean, causing more than 30 per cent yield losses.

Colletotrichum truncatum is the most common species recorded on soybean. The disease cause considerable damage by reducing plant stand, seed quality seed germination and yield. Therefore, present investigations on *C. truncatum* were undertaken with the objectives viz., survey, isolation and identification, pathogenicity, *in vitro* efficacy of fungicides, bioagents and botanicals.

The survey studies indicated that the pod blight (*C. truncatum*) was of common occurrence and distributed throughout all nine tahsils of Parbhani districts. The pathogen (*C. truncatum*) isolated successfully from the naturally diseased soybean plants specimens (foliage and pods) collected during survey. The typical symptoms of the disease observed during survey, pathogenicity test and field experiments were on the foliage brown coloured patches with grey coloured centre on upper surface and scorched appearance on the lower surface, pods covered with small to large, irregular brown blotches, which later turned black. Infected pods found to be shriveled and contain no seed or two seeded pods.

Pathogenicity of test pathogen was proved by applying Koach's postulates and using susceptible soybean Cv. JS-335 under controlled conditions of the screen house. Based on symptomatology, cultural and morphological characteristics, microscopic observations and pathogenicity test, the test pathogen was identified as *C. truncatum* and its further identity was confirmed.

Studies on *in vitro* evaluation of the fungicides, bioagents and the botanicals revealed that all the treatments significantly inhibited mycelial growth of the test pathogen over untreated

control. However, systemic fungicides viz., Propiconazole, Hexaconazole, Carbendazim; non systemic fungicides viz., Mancozeb 63% + Carbendazim 12%, Metalaxyl, Mancozeb; bioagents viz., *T. viridae*, *T. harzianum*, *T. longibrachiatum*, *T. koningi*, *A. niger*, *A. flavus* and botanicals viz., *Curcum longa*, *Lantena camera*, *Allium sepa*, *Dhattura metal*, *Ocimum sanctum*, *Azardirecta indica* and *NSKE* were most effective and economical respectively for the management of disease during *Kharif* 2016.

Title	- Optimization of fungicidal spray schedule for the management of sigatoka leaf spot disease of banana caused by <i>Mycosphaerella musicola</i> L., cv. grand naine
Researcher	- Meena, Surendra Kumar
Research Guide	- Deshmukh, R.V.
Department	- Plant Pathology
Subject	- Plant Pathology
Degree	- M.Sc
Thesis No.	- 1736
Krishikosh link	- http://krishikosh.egranth.ac.in/handle/1/5810033320
Abstract	-

The present investigation on “Optimization of fungicidal spray schedule for the management of sigatoka leaf spot disease of banana caused by *Mycosphaerella musicola* L., cv. Grand Naine” was carried out with an objective to optimize the fungicidal spray schedule for the management of yellow sigatoka leaf spot disease of banana. During the course of present investigation, a field experiment was conducted on farmer’s field of village Barad, Tq. Mudkhed, District-Nanded in randomized block design, replicated three times with eight treatments of fungicides spray viz., T1-single spray of Dithane M-45 75 WP @0.25%, T2-single spray of Azoxystrobin 25 EC @0.06%, T3-Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S two sprays at 15 days interval), T4-Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C three sprays at 15 days interval), T5- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S four sprays at 15 days interval), T6- Spraying of Dithane M- 45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval), T7- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval), T8- Control, were used to optimize the spray schedule of these fungicides on the intensity of sigatoka leaf spot disease and yield contributing characters of banana. Lastly, it can be concluded that treatment T6 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C five sprays at 15 days interval) and treatment T7- Spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% (C→S→C→S→C→S six sprays at 15 days interval), recorded significantly minimum percent disease index of sigatoka leaf spot (19.85% and 20.12% respectively) and obtained maximum yield of banana in treatment T7 (91.26 Mt/ha).

In field survey, total twenty two banana gardens were selected for surveying different diseases of banana from Nanded, Parbhani, and Hingoli districts of Marathwada region. Survey programme was conducted in the month of October, 2016 and March, 2017. The disease severity index of sigatoka was found in severe form during October surveying as compared with March surveying, and was observed in the range of 10.5 to 25.0 percent and was recorded maximum from village Pimpalkautha (Magre) (25.0 percent) during October surveying. The severity of sigatoka leaf spot was found less during March surveying and was observed in the range from 10.0 to 22.3 percent and reported maximum from the village Pimpalkautha (22.3%) during March, 2017 surveying. The incidence of Erwinia rot was reported maximum (17.0%) from the gardens selected from village Borgaon and Pimpalkautha during October surveying. The maximum incidence of Banana streak virus (10%) was recorded from the gardens selected from village Mudkhed Tq. Mudkhed, Padharwadi, Pardi and Singapur. The maximum incidence of Infections chlorosis (15%) was recorded from the gardens selected from village Pandharwadi and Barad, Tq. Mudkhed.

In the efficacy of consequent, alternate and mix spraying of contact and systemic fungicide experiment against sigatoka leaf spot disease of banana, Significantly minimum percent disease severity index of sigatoka (16.67%) was recorded by the treatment T3 i.e. spraying of Dithane M-45 @0.25% alternated with spraying of Azoxystrobin @0.06% and significantly maximum banana yield (80.55Mt/ha) was recorded by the treatment T3 i.e. Spraying of Dithane M-45 @0.25% in alternation with the spraying of Azoxystrobin @0.06%. Total six sprayings were conducted at 15 days interval.

Title	-	Evaluation of biocontrol potential of native <i>Trichoderma</i> spp. against soil borne pathogens
Researcher	-	Kale, Gopikiran Janadhan
Research Guide	-	Magar, S.J.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	1755
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810033461
Abstract	-	

Trichoderma species are used as biocontrol agents in agriculture. *Trichoderma*, a genus of asexually reproducing saprophytic fungi, frequently present in nearly all temperate and tropical soils, decaying plant tissues and root ecosystems. The strains of *Trichoderma* spp. are strong opportunistic invaders, fast growing, prolific producers of spores and powerful antibiotic producers.

16 samples were collected from different crops. The *Trichoderma* spp. from these samples was isolated on TSM medium by using serial dilution method. Out of these only 8 rhizospheric soil samples had the population of *Trichoderma* spp. By visual observations, *T. viride*, *T. harzianum*, *T. hamatum* were identified.

The result obtained on mycelial growth and inhibition of *Fusarium oxysporum* f. sp. *lycopersici* with two *T. viride*, four *T. harzianum*, two and *T. hamatum* isolates antagonists. All the isolates of *Trichoderma* exhibited fungistatic/ antifungal activity against *F.oxysporum* f. sp. *lycopersici* and *Sclerotium rolfsii* and significantly inhibited its growth over untreated control of the eight antagonists (8 isolates) tested, It was observed that treatment *T. harzianum* (T₈) was found most effective isolate obtained from Aurangabad district showed highest zone of inhibition i.e. after 24,48,72,96 hrs of incubation 00, 94, 84.28, 57.03 per cent followed by T₃ (*T. hamatum*) Latur district isolate i.e.00, 90.16, 75.44, 56.81 and T₂ (*T. viride*) hingoli district isolate i.e. .00, 4.26, 22.73, 38.79, per cent. For *Fusarium oxysporum* f.sp. *lycopersici* respectively. And for *Sclerotium rolfsii* *T. hamatum* (T₃) was found most effective isolate obtained from Latur district showed highest zone of inhibition i.e. after 24,48,72,96 hrs of incubation 00, 8.33, 61.78, 62.21, per cent followed by T₅ (*T. hamatum*)

Osmanabad district isolate i.e.00, 8.11, 60.82, 56.33 and T₂ (*T. viride*) Hingoli district isolate i.e.00, 8.11. 60.11. 56.06 per cent. Respectively.

In methods of application *In vitro* evaluation of various isolates of *Trichoderma* against *Fusarium oxysporum* f. sp. *lycopersici* isolate A. bad-1(T₈) *T. harzianum* was found most effective which was isolated from Aurangabad district so to asses various methods of application of *Trichoderma* spp. in tomato against *Fusarium oxysporum* f. sp. *lycopersici*, *Trichoderma harzianum* is used. Result indicate that seed treatment (T₁) was found most effective as compared with rest of treatments in which seed germination 100% Pre-emergence mortality 21.13 and Post emergence mortality 0.00% and total Mortality due to pathogen was 13.33%, respectively. This was followed by (T₄) Seed treatment + Soil application germination % 96.66, Pre-emergence mortality 29.45%, Post-emergence mortality 9.27% and total mortality 35.18%, respectively. The treatment (T₂) seedling root dip method recorded least 96.66 PREM 33.67, POEM 16.38 and Total mortality 41.48, respectively.

In *in vitro* evaluation of various isolates of *Trichoderma* against *Sclerotium rolfsii* isolate (T₃) Thm-L *T. hamatum* was found most effective which was isolated from latur so to asses various methods of application of *Trichoderma* spp. in tomato against *Sclerotium rolfsii*, *Trichoderma hamatum* is used these (T₄) Seed treatment + Soil application was found most effective as compared with rest of treatments which recorded seed germination was 100% Pre emergence mortality 14.99 , Post-emergence mortality 3.70 % and total Mortality due to pathogen 17.70%, respectively. This was followed by treatment (T₅) Seedling root dip + Soil application, which recorded germination 100%, Pre-emergence mortality 14.99% , Post emergence mortality 7.87% and total mortality 19.91%, respectively.

Title	- Studies on variability of xanthomonas axonopodis pv. punicae causing bacterial blight of pomegranate and their sensitivity to various chemicals
Researcher	- Sahane, Satish Prabhakar
Research Guide	- Ambadkar, C.V.
Department	- Plant Pathology
Subject	- Plant Pathology
Degree	- M.Sc
Thesis No.	- 1783
Krishikosh link	- http://krishikosh.egranth.ac.in/handle/1/5810033661
Abstract	-

Bacterial blight disease of pomegranate caused by *Xanthomonas axonopodis* pv. *punicae* is one of the most destructive disease of pomegranate (*Punica granatum*) inflicting considerable quantitative and qualitative losses. Mostly the disease occurred on leaves, stems and fruits. Considering the economic importance of the fruit crop as well as disease, present investigation was undertaken to conduct survey, isolation, identification, pathogenicity, study of different characters of pathogen, molecular variability of selected isolates and *in vitro* evaluation of different antibiotics and chemicals against the disease.

Results of the disease survey showed that the 100 per cent bacterial blight incidence was observed in Badnapur and Jalna followed by Jafrabad (80%) and Ambad (66.66 %) in Jalna district, whereas in Latur district, 100 per cent disease incidence was found in Deoni and Nilnga tahsil followed by Chakur (80 %) and Ausa (66.66 %). In Osmanabad district the disease incidence was maximum in Kalamb (100 %) followed by Omarga (66.66 %), whereas, in Beed district bacterial blight incidence was maximum in Ashti (75 %) followed by Kej (55.55 %).

The bacterium was successfully isolated on Nutrient Agar basal culture medium. It produced pale yellow mucoid, shiny, glistening, bacterial colonies. Pathogenicity test was performed on cv. Bhagwa by using pin prick method and spray inoculation method. The symptoms of the disease were developed within 8 to 13 days after inoculation on leaves.

Cultural and morphological characters such as colony colour and colony shape, cell shape, appearance, colony margin elevation and texture of *X. axonopodis* pv. *punicae* were studied on different culture media.

The studies on biochemical characteristics of *X. axonopodis* pv. *punicae* showed their positive reactions for potassium hydroxide (KOH) solubility test, starch hydrolysis test,

Gelatin liquification, H₂S Production and Carbohydrate fermentation whereas, negative response for Gram staining.

Six *Xap* isolates collected during survey were tested for their growth characteristics at temperature of 28⁰C and 37⁰C on NA agar. All isolates grew well at 27⁰C but no growth was observed at temperature of 37⁰C. Growth of *Xap* started 72 hrs after incubation. Maximum growth was observed after 120 hrs of incubation at 28⁰C but no growth was observed after 48 hrs of incubation.

The primer OPA09, ABA05 and ABA07 was found most significant by producing 100 per cent polymorphism amongst 03 strains of Latur, Osmanabad and Beed districts, whereas, Primer OPC03, OPH02 and OPC20 was found most significant by producing 100, 100 and 90.91 per cent polymorphism amongst 02 strains of Jalna districts.

The studies on *in vitro* evaluation of different antibiotics and chemicals against *X. axonopodis* pv. *punicae* revealed that antibiotic Streptocycline 500ppm + Copper oxychloride 0.25% was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 42.44 per cent inhibition zone.

Title	-	Studies on management of chickpea wilt caused by <i>Fusarium oxysporum</i> f. sp. <i>ciceri</i> (padw.) snyd. and hans
Researcher	-	Bangar, Dnyaneshwar Kailas
Research Guide	-	Dadke, M.S.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	1791
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810033674
Abstract	-	

Wilt disease caused by *Fusarium oxysporum* f. sp. *ciceri* (Padw.) Snyd. and Hans. is one of the most destructive and wide spread disease of chickpea causing cent percent losses under favorable conditions (Suman Patra and Mohan Kumar Biswas, 2017). Present studies were carried out during Rabi 2016-17 with objectives viz., cultural and morphological characteristics, *in vitro* efficacy of fungicides and bioagents, pot culture evaluation of effective fungicides and bioagent with combinations and screening of chickpea cultivars against *Fusarium* wilt.

Cultural and morphological studies, revealed that among the different media tried, Czapek's Dox Agar (90.00 mm), Host Leaf Extract Agar (82.90 mm), Oat Meal Agar (80.90 mm) and Potato Dextrose Agar (80.20 mm) produced good growth of *F. oxysporum* f. sp. *ciceri*. Systemic fungicide Carbendazim, non-systemic fungicide Copper -oxychloride and combi fungicide Carbendazim + Mancozeb were found highly effective in inhibiting mycelial growth of *F. oxysporum* f. sp. *ciceri*. Among the different bioagents tested by dual culture technique *Trichoderma viride* was found to be effective in inhibiting the mycelial growth of *F. oxysporum* f. sp. *ciceri* followed by *T. harzianum*. In pot culture experiment, seed treatment with *T. viride* recorded lowest wilt incidence (30.00%), highest root length (16.58 cm) and highest yield (12.56g/pot) followed by seed treatment with a combi fungicide Carbendazim + Mancozeb, which recorded 33.33% wilt incidence, 15.62 cm root length and 11.59g/pot seed yield. In a pot culture studies of combination of systemic and combi fungicides with bioagent evaluated against *F. oxysporum* f. sp. *ciceri* revealed that highest yield of 15.65g/pots was recorded from treatment T₇ followed by T₆ (15.38g/pot), T₉ (14.87g/pot) and T₈ (14.81g/pot). Screening under artificial inoculation conditions in pot culture revealed that out of 22 cultivars only two cultivars recorded resistant reaction, five cultivars were moderately

resistant, four tolerant, six moderately susceptible and five cultivars recorded susceptible reaction which needs to be confirmed under sick plot method.

Title - **Studies on compatibility of *trichoderma* spp. with agrochemicals**

Researcher - Kashid, Vishal Shravan

Research Guide - Suryawanshi, A.P.

Department - Plant Pathology

Subject - Plant Pathology

Degree - M.Sc

Thesis No. - 1792

Krishikosh link - <http://krishikosh.egranth.ac.in/handle/1/5810033675>

Abstract -

Present investigation entitled “Studies on compatibility of *Trichoderma* spp. with agrochemicals” was undertaken at the Department of Plant Pathology, College of Agriculture, Latur, during 2016-17.

All 18 rhizospheric soil samples collected and isolated on PDA evidenced predominantly the prevalence of *T. harzianum* and *T. hamatum*, based on macroscopic and microscopic observations and their comparisons with authentic descriptions, the two most predominant species identified were *T. harzianum* and *T. hamatum*. On various culture media tested, both the species exhibited a wide range of variations in their morpho-cultural characteristics. Further, both the species responded differently to the major physiological factors *viz.*, temperature regimes and pH concentrations. However, the temperature in the range of 25°C to 35°C was found most congenial; whereas, *T. harzianum* grew better in the pH range of 5.5 to 8.5, except 6.0 and 6.5 and that of *T. hamatum* grew better at pH 7.0, 5.5 and 8.5.

The compatibility studies revealed that both *T. harzianum* and *T. hamatum* were highly compatible with two systemic fungicides *viz.*, fosetyl-Al 80% WP and hexaconazole 5% EC; two non-systemic fungicides *viz.*, copper oxychloride 50% WP and copper hydroxide 53.8% ww. However, rest of the systemic, contact and combi (contact + systemic) fungicides were found incompatible with both of the *Trichoderma* spp., at various concentrations tested. Similarly, both the species were highly compatible with the insecticides *viz.*, acephate 75% SP, fenvalerate 0.4% DP, imidacloprid 17.8% SL, acetamiprid 20% SP and thiamethoxam 25% WG, at their recommended field dosages.

Thus, it has been concluded that in the soils of College of Agriculture and Oilseed Research Station, Latur, *T. harzianum* and *T. hamatum* are prevailing predominantly. Both the species

could proliferate better at a wide range of pH and at mesophilic temperature range of 25°C to 35°C. Both the species are compatible with very few fungicides and maximum number of insecticides, which are commonly used in plant protection.

Title - **Studies on papaya ring spot virus (PRSV) in papaya**

Researcher - Limkar, Sandhya Suraj

Research Guide - Magar, S.J.

Department - Plant Pathology

Subject - Plant Pathology

Degree - M.Sc

Thesis No. - 1794

Krishikosh link - <http://krishikosh.egranth.ac.in/handle/1/5810033678>

Abstract -

Papaya, the poor man's fruit of the tropics encompasses most of the desirable qualities of a fruit. Papaya belongs to the family Caricaceae. The papaya ring spot virus disease (PRSV) caused by potyvirus is a well-known aphid and sap transmissible plant pathogenic virus in the genus Potyvirus and family Potyviridae. Among viral diseases papaya ring spot virus is a wide spread pathogen that can cause up to 90% yield losses in papaya. (Singh et al., 2013). Symptoms on mechanical transmission were characterized by vein clearing followed by chlorosis, yellow mosaic, blistering and leaf distortion. Later on necrotic spots developed leading to complete necrosis of leaves, petioles and stem.

The result on aphid transmission revealed that three aphid spp. *Aphis gossypii*, *Aphis craccivora*, and *Myzus persicae* were found to transmit the virus in non persistent manner from papaya (*Carica papaya*) to papaya. *Myzus persicae* was found to be more efficient (90%) than *Aphis gossypii* (80%) and *Aphis craccivora* (50%) transmitting the virus.

The virus was successfully transmitted by sap inoculation method in plants belonging to families Caricaceae (*Carica papaya*), cucurbitaceae (*Cucumis sativus*, *Cucurbita moschata*, *C. pepo*, *Luffa acutangula*, *L. cylindrica*, *Lagenaria siceraria*, *Momordica charantia*) with systemic mosaic mottling symptoms. However, plants of families Chenopodiaceae (*Chenopodium amaranticolor*, *Chenopodium quinoa*) produced local lesions. Results on Biophysical properties such as thermal inactivation point revealed that the virus was found active at a temperature upto 50°C but it was

inactivated at 55°C. The virus remained infective in sap extracted from diseased leaves of papaya at 1: 1000 dilutions but not at 1: 10000 dilutions. The longevity of virus was recorded between 8 and 10 hrs at room temperature. Results on the electron microscopy of the purified preparations of PRSV revealed the presence of flexuous rod shaped particles at different magnifications. The size of the virus particles measured was 750nm in length and 12-13 nm in width.

Title	-	Efficacy of synthetic antibiotics and chemicals in management of bacterial blight of Pomegranate
Researcher	-	Patil, Ashwini Govindrao
Research Guide	-	Ambadkar, C.V.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	1795
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810033679
Abstract	-	

Present investigation on Efficacy of synthetic antibiotics and chemicals in management of bacterial blight of Pomegranate in respect of isolation, identification, pathogenicity, morphological, cultural and physiological characterization and evaluation of antibiotics and chemicals (*In vitro and In vivo*) against the disease was carried out during monsoon 2016 at Department of Plant Pathology, College of Agriculture, Latur and field study on the farmer's orchard at Village Naigaon in Dist. Osmanabad.

Five different isolates collected from Latur and Osmanabad district were subjected to pathogenic variability amongst these isolates. Amongst five isolates *Xap -4* isolate had more lesion size i.e 0.9 mm after 15 days of inoculation and 4.3 mm after 18 days of inoculation which showed water soaked circular to irregular dark brown spots with yellow halo symptoms. The isolate *Xap -3* showed 0.7 mm lesion size after 15 days and 4.1 mm after 18 days after inoculation showing water soaked circular to irregular, light brown spots, whereas, the *Xap- 1* isolate showed less lesion size i.e 0.3 mm after 15 days and 3.5 mm after 18 days of inoculation.

The temperature of 28°C was found optimum for the growth of the pathogen as significantly maximum number of colonies were observed at this temperature. The isolates *Xap -2* and *Xap- 3* showed maximum growth at 120 hrs, moderate growth at 72 hrs, and less growth at 42 hrs., whereas, isolates *Xap -1*, *Xap -2*, *Xap-3* did not show any growth at 48 hrs, but less growth at 72 hrs and maximum growth at 120 hrs. No growth of bacterium was found at 37 °C in all isolates i.e *Xap-1*, *Xap-2*, *Xap-3*, *Xap-4*, *Xap-5*. Maximum growth of *Xap* isolates was observed at pH 6.5 and 7, whereas, moderate growth of *Xap-2*, *Xap-3*, *Xap-4*, *Xap-5* isolates was observed at pH 6.0 except *Xap-1* which showed less growth at pH 6.0. Isolate *Xap-2*, *Xap-3* and *Xap-5* showed less growth at pH level 5.5, whereas, *Xap-1* and

Xap-4 showed no growth at pH 5.5. All the isolates failed to grow at pH 5.0.

In vitro study revealed that chemical Nanocopper showed maximum average inhibition zone of 26.91 per cent at 500 ppm concentration against *X. axonopodis* pv. *punicae*,

followed by same chemical at 300 ppm and 100 ppm which showed 20.22 and 18.86 percent inhibition. Field study revealed that chemical Nano copper at 500, 300 and 100 ppm were found most effective in controlling the disease by recording 59.53, 50.09 and 49.82 per cent disease control, respectively. The maximum per cent fruit setting i.e 77.67 per cent was observed in the treatment of Nano copper@500 ppm followed by Nano copper @ 300 and 200 ppm which recorded 75.67 and 72 per cent fruit setting, respectively. Maximum yield of 16.08 tonnes/ha was observed in the treatment of Nano copper@500 ppm followed by Nano copper @ 300 and 200 ppm which recorded 15.31 and 15.14 tonnes/ha fruit yield, respectively.

The data of economics in respect of net returns and cost benefit ratio revealed that maximum gross returns of Rs.723942/- with maximum net returns of Rs. 504560/- and C:B ratio 1:3.29 over unsprayed control treatment was observed in the treatment of Nano copper at 500 ppm concentration., whereas, minimum net returns of Rs. 313447/- and B:C ratio of 1:2.50 was recorded in the treatment of Hydrogen peroxide @ 100 ppm. Amongst all the treatment least net returns of Rs. 279340/- and least B:C ratio 1: 2.35 was observed in control treatment.

Title	-	Studies on plant growth promotion by <i>Azospirillum</i> spp. on jowar (<i>Sorghum bicolor</i> L.)
Researcher	-	Savle, Shajaji Atmaram
Research Guide	-	Navgire, K.D.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	17109
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810033725
Abstract	-	

Sorghum is an important cereal crop in the world next to wheat, rice and maize. In India, it stands third in respects of area and production among cereals and most important source of food for rural community and working class, for the taming cattle population and also for raw material in industries.

Azospirillum is considered to be an associative symbiotic bacterium as it lives in close association with root system of plant. These bacteria colonizing the roots and not only remain on the root surface but also sizable proportion of them penetrates into the root tissue and live in harmony with the plants.

Initially *Azospirillum* isolated from roots of sorghum crop on N-free semisolid Nfb medium. Four different culture broth viz., nutrient broth, potato dextrose broth, LGI broth, and TYG broth were used for mass multiplication. Good bacterial growths were observed in TYG broth followed by nutrient broth. *Azospirillum* inoculation significantly improved the shoot length, root length, fresh shoot, dry shoot weight and total N-content of sorghum on all dates of observation. The maximum shoot length, root length, fresh shoot weight, dry shoot weight and total N-content were observed in inoculated with *Azospirillum* as compared to un-inoculated seeds.

The highest shoot length, root length, fresh shoot, dry shoot weight and total N-content were observed with treatment of application of 75 per cent nitrogen of RDF through urea on 10, 20, 30, 40 and 50 days after sowing as compared to no nitrogen.

The interaction effects of *Azospirillum* inoculation and nitrogen application were nonsignificant indicating no inter-dependence of these two factors for shoot length, root length, fresh shoot weight, dry shoot weight and total N-content of sorghum crop.

Growth parameters and total nitrogen content of sorghum plant was found to be significantly increased due to application of 75 per cent nitrogen of RDF and inoculations of *Azospirillum*. Hence *Azospirillum* can be exploiting in sowing of sorghum to save the nitrogenous fertilizer.

Title	-	Investigations on alternaria leaf spot of cabbage caused by <i>Alternaria brassicae</i> (Berk.) Sacc.
Researcher	-	Patwari, Sujit C
Research Guide	-	Mulekar, V.G.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	17162
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810034038
Abstract	-	

Cabbage (*Brassica oleracea*) *alternaria* leaf spot caused by *Alternaria brassicae* (Berk.) Sacc. is one of the constraints in the profitable cultivation of cabbage. The yield losses due to *Alternaria* leaf spot/blight (*A. brassicae*). Hence, present studies on *Alternaria* leaf spot/blight cabbage were carried out with the objectives *viz.*; survey, isolation and pathogenicity, *in vitro* evaluation fungicides, bioagents and integrated disease management strategies (pot culture) at Department of Plant Pathology, College of Agriculture, VNMKV, Parbhani.

Cabbage field's survey among the Parbhani, Latur and Osmanabad district, the disease incidence was more in Omerga (23.25%), followed by Purna (21.50%), Lohara (20.25%). The highest percent disease severity of *alternaria* leaf spot/blight disease was observed in Purna (31.86%), followed by Latur (31.22%), Gangakhed (27.75%). Results of cabbage varietal response against *alternaria* leaf spot/blight revealed that, maximum disease incidence was recorded on cv. Vigro golden (23.33%) and minimum on Cv. Agro 80 (15.00%). The maximum severity was recorded on Charmy (34.25%), lowest recorded in sungrow (26.77).

Pathogenicity of test fungus was proved on plants of cabbage Cv. Sungrow in pot culture under screen house conditions. Based on symptomatology, microscopic observations and pathogenicity test, the test pathogen was identified as *Alternaria brassicae* (Berk.) Sacc. and its further identity was confirmed

Studies on *in vitro* evaluation of the fungicides, bioagents and the botanicals revealed that all the treatments significantly inhibited mycelial growth of the test pathogen over untreated control. However, systemic fungicides (each @ 500, 1000 and 1500 ppm)

recorded, Hexaconazole (100%), Propiconazole (97.80%), Pyraclostrobin (96.32%), Azoxystrobin (95.78%) inhibition, non-systemic fungicides (each @ 2000, 2500 and 3000 ppm) recorded, Mancozeb (89.80%), Copper hydroxide (86.04%), Copper oxychloride (80.19%) inhibition and combi-fungicide (each @ 1000, 1500 and 2000 ppm) recorded, Carbendazim 25% + Mancozeb 50% (89.79%), Carboxin 37.5% + Thiram 37.5% (88.59%), Hexaconazole 4% + Zineb 68% (88.00%), Carbendazim 12% + Mancozeb 63% (82.74%) inhibition. Bioagents viz.; *T. viride*, *T. harzianum* and *T. longibrachiatum* recorded significantly highest inhibitions of 80.64, 76.96 and 73.06 per cent, respectively. Phytoextracts *A. sativum* followed by *A. indica* caused significantly highest mycelial inhibition, respectively of 82.93 and 80.04 per cent.

The integrated disease management studies indicated that significantly least average disease incidence and its highest average reduction were recorded with the fungicides, Hexaconazole (18.75 and 59.70%), Propiconazole (20.14 and 56.72%) and Carbendazim 25% + Mancozeb 50% (21.53 and 53.73%) respectively over untreated control. These studies also indicated that significantly least disease intensity and its highest reduction recorded with Hexaconazole, (8.14 and 78.60%), Propiconazole (10.45 and 72.51%) and Carbendazim 25% + Mancozeb 50% (11.99 and 68.45%) respectively over untreated control.

Title	-	Studies on plant growth promotion by <i>Gluconacetobacter diazotrophicus</i> in sorghum
Researcher	-	Giri, Vinayak Vishnu
Research Guide	-	Navgire, K.D.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	17178
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810034064
Abstract	-	

Sorghum (*S. bicolor* (L.) Monch.) is main source of food as well as fodder crop in India and holds a prominent position as a cereal crop. Nitrogen is an essential plant nutrient, widely applied as N-fertilizer to improve yield of agriculturally important crops. An interesting alternative to avoid or reduce the use of N-fertilizers could be the exploitation of plant growth-promoting bacteria (PGPB), capable of enhancing growth and yield of many plant species of agronomic and ecological significance.

Gluconacetobacter diazotrophicus was found more efficient for biological nitrogen fixation in sorghum which is an endophytic organism that colonies in the roots and shoot of sorghum. Biological nitrogen fixation is important in agriculture because it provides a source of fixed nitrogen for growth of plants that is non-polluting and not dependent on fossil fuels for production. A lab study showed that LGI medium was best suited for isolation, purification, maintenance and mass multiplication of *G. diazotrophicus*. N-free LGI broth was found to be suitable for mass multiplication of *G.diazotrophicus*.

G. diazotrophicus inoculation significantly improved the shoot and root length of sorghum on all dates of observation. The maximum shoot and root length was observed in inoculated pots as compared to un-inoculated pots.

The highest shoot and root length was observed with 75 per cent nitrogen of RDF through urea as compared to no nitrogen at 10, 20, 30, 40 and 50 days after sowing.

G. diazotrophicus inoculation significantly improved the shoot fresh and dry weight of sorghum on all dates of observation with application of 75 per cent nitrogen of RDF through urea as compared to no nitrogen.

G. diazotrophicus inoculation also significantly improved the total nitrogen content of sorghum on all dates of observation with application of 75 per cent nitrogen of RDF through urea as compared to no nitrogen.

The interaction effects on shoot and root length, shoot fresh and dry weight and total nitrogen in plant due to *G. diazotrophicus* inoculation and nitrogen application were non-significant indicating no inter-dependence of these two factors.

Growth parameters with total nitrogen content in sorghum plant were significantly increased with combined application of 75 per cent dose of nitrogenous fertilizer and liquid formulation of *G.diazotrophicus*. Hence *G.diazotrophicus* can be exploited while sowing of sorghum to save the nitrogenous fertilizer.

Title	- Biosynthesis of silver nanoparticles (AgNPs) by using <i>Trichoderma harzianum</i> and its efficacy against soilborne plant pathogens of Tomato
Researcher	- Shendge, Vijay Subhash
Research Guide	- Magar, S.J.
Department	- Plant Pathology
Subject	- Plant Pathology
Degree	- M.Sc
Thesis No.	- 17191
Krishikosh link	- http://krishikosh.egranth.ac.in/handle/1/5810034118
Abstract	-

The genus *Trichoderma* was first proposed as a genus more than two hundred years ago by Persoon in 1794 at Germany. *Trichoderma*, a fungi, which grow saprophytically in soils have proved as an effective biocontrol agent of soilborne plant diseases specifically wilt caused by different pathogens like; *Pythium* spp., *Fusarium oxysporum*, *Sclerotium rolfsii*, *Rhizoctonia solani* and *Phytophthora* spp.

A soil sample was collected from rhizosphere of tomato crop. The *T. harzianum* from this sample was isolated on PDA by using serial dilution method. It was morphologically identified by using characters such as colony growth rate, reverse colony colour, colony colour, colony edge, alongwith morphology of conidia, shape and size, phialids numbers, conidial shapes, size, branching of conidiophores etc.

The culture filtrate of *Trichoderma harzianum* was used for the reduction of silver ions (Ag^+) in AgNO_3 solution to the silver (Ag^0) nanoparticles. The different ages (4 days, 6 days, 8 days, 12 days and 15 days) of culture filtrates were screened for the synthesis of silver nanoparticles. Synthesized silver nanoparticles were characterized using UV-Vis spectrophotometer and Transmission Electron Microscopy (TEM). Among the all treatments the silver nitrate solution treated with six days aged culture filtrate of *Trichoderma harzianum* showed the UV absorption peak at 440 nm with maximum intensity after 24 hrs of incubation. The TEM micrographs showed the spherical shape silver nanoparticles with an average size of 50 nm.

The antifungal activity of silver nanoparticles evaluated against *Fusarium oxysporum* f. sp. *lycopersici* and *Sclerotium rolfsii* pathogens by Agar well diffusion method and Poison food technique. In Agar well diffusion method, the zone of inhibition of silver nanoparticles at 100 ppm concentration observed as 18.66 mm and 17.00 mm against *F. oxysporum* f. sp. *lycopersici* and *Sclerotium rolfsii* isolates, respectively.

In Poisoned food technique, the suspension of silver nanoparticles at 100 ppm concentration, the per cent inhibition were observed as 75.19% and 68.53% against *F.oxysporum* f. sp. *lycopersici* and *Sclerotium rolfsii* isolates, respectively. The results points to the usage of these mycogenic AgNPs in agriculture to control plant diseases.

Title - **Studies on seed mycoflora of sunflower (*Helianthus annuus* L.)**

Researcher - Patil, Ashutosh Chandrakant

Research Guide - Suryawanshi, A.P.

Department - Plant Pathology

Subject - Plant Pathology

Degree - M.Sc

Thesis No. - 17192

Krishikosh link - <http://krishikosh.egranth.ac.in/handle/1/5810034120>

Abstract -

The present investigation “Studies on seed mycoflora of sunflower (*Helianthus annuus* L.)”, was conducted during 2016-17 at the Department of Plant Pathology, College of Agriculture Latur, with the objectives *viz.*, to isolate and prove pathogenicity, to detect by various SHT methods the fungi associated with sunflower seeds and to evaluate *in vitro* the efficacy of seed dressing fungicides and bioagents against major fungi pathogenic to sunflower

All of the five seed health testing (SHT) methods employed were found efficient in the detection of sunflower seed mycoflora, in their order of merit as Blotter paper 2-4, D > Agar plate > Modified PDA > Rolled towel paper. These SHT methods revealed the association of five major fungi *viz.*, *A. alternata*, *F. oxysporum*, *A. niger*, *A. flavus* and *R. stolonifer*, with the stored seeds of sunflower Hyb. LSFH-171 and var. Morden. All of these fungi were found pathogenic to sunflower and also found to affect seed germination, root and shoot length and seedling vigor index of sunflower.

Among major five fungi detected, per cent frequency of association / incidence was found highest with the seeds of sunflower Hyb. LSFH -171 in respect of *A. alternata* (67.33-78.25%), followed by *F. oxysporum* (64.50-72.41%), *R. stolonifer* (51.50-72.25%), *A. niger* (52.66-71.83%) and *A. flavus* (50.08-64.75%). Whereas, with the seeds of var. Morden, the frequency of association / incidence of these five fungi was comparatively of minimum degree in respect of *A. alternata* (70.75-67.83%), followed by *F. oxysporum* (66.33-71.50%), *A. flavus* (50.41-50.56%), *R. stolonifer* (43.16-75.41%) and *A. niger* (46.83-67.33%)

Among nine seed dressing fungicides evaluated *in vitro* at their recommended field dosages, cent per cent (100%) mycelial growth inhibition of *Alternaria alternata* and *Fusarium oxysporum* was resulted with the fungicides *viz.*, thiophanate methyl 70% WP,

benomyl 50% WP, carbendazim 50% WP, thiram 75% WP, carbendazim 25% + mancozeb 50% WP and carboxin 37.5% + thiram 37.5% .Among nine bioagents evaluated *in vitro*, significantly highest mycelial growth inhibition of *Alternaria alternata* was resulted with *A. niger* (97.80%), *T. virens* (79.40%), *T. viride* (78.10%) , and rest of the *Trichoderma* spp. caused mycelial growth inhibition in the range of 77.20- 77.60 per cent, followed by *P. fluorescens* 50.40%. Whereas, in *F. oxysporum*, significantly highest mycelial growth inhibition was with *T. koningii* (76.02%), followed by *T. lignorum* (75.50%), *A. niger* (75.30%) and *T. harzianum* (33.10%), later three were on par with each other.

Thus, seedborne pathogenic fungi of sunflower can be managed effectively by seed treatment with either systemic or contact + systemic fungicides as well as with various *Trichoderma* spp.

Title	-	Studies on variability and integrated management of turmeric rhizome rot caused by <i>pythium aphanidermatum</i> (Edson) Fitzp.
Researcher	-	Chavan, P.G.
Research Guide	-	Apet, K.T.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	Ph.D.
Thesis No.	-	17199
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810034132
Abstract	-	

Rhizome rot caused by *Pythium aphanidermatum* (Edson) Fitzp. is one of the most wide spread and destructive disease of turmeric (*Curcuma longa* L.). The pathogen causes yield losses to the tune of 40-50 per cent. Therefore, present investigations on *P. aphanidermatum* with the objectives viz., survey, symptomatology, pathogenicity, cultural, morphological, pathogenic and molecular variability amongst *P. aphanidermatum* isolates, *in vitro* efficacy of fungicides, bioagents, botanicals and soil amendments, integrated disease management strategies (*in vitro* and *in vivo*), induced systemic resistance and screening of turmeric varieties were undertaken during 2014-15 to 2016-17 at VNMKV, Parbhani (M.S.), India.

The survey studies indicated that rhizome rot (*P. aphanidermatum*) disease is of common occurrence and widely distributed in the agro-climatic zones of Maharashtra, with its maximum incidence during, *Kharif* 2016-17 than that of *Kharif* 2015-16 season. The pooled (*Kharif*, 2015-16 and 2016-17) results revealed maximum mean rhizome rot incidence in Transitional zone-I (29.64 %), followed by Transitional zone-II (26.40 %), Moderate rainfall zone (20.48 %), Assured Rainfall zone (16.49 %) and Scarcity zone (15.77 %). Among various turmeric varieties grown by the farmers of Maharashtra, Cv. Cuddappa was found to be more susceptible to the disease followed by Tekkerpeta.

The pathogen was isolated successfully from the naturally diseased turmeric rhizome rot samples collected during survey were obtained, purified and maintained. The typical symptoms of rhizome rot observed during survey, pathogenicity test and field experiments were: yellowing of lower leaves result in partial or complete blighting. Water soaked lesions appear on the pseudostems. Affected pseudostems topple off with a gentle

pull. The infection spreads from roots to rhizome causing soft rot, rotted rhizomes emit foul smell. Pathogenicity test attempted by applying Koch's postulates on susceptible turmeric Cv. Selum under controlled conditions of the screen house, confirmed the association of *P. aphanidermatum* with turmeric rhizome rot. Based on symptomatology, cultural and morphological characteristics, microscopy and pathogenicity test, the test pathogen was identified as *Pythium aphanidermatum*.

Cultural, morphological, pathogenic and molecular studies revealed a wide range of variability among the 9 isolates of *P. aphanidermatum*, which represented five agro-climatic zones of Maharashtra.

In vitro studies on fungicides revealed Metalaxyl and Carbendazim 12 WP + Mancozeb 63 WP (each @ 100 %), followed by Carbendazim (97.67 %), Copper oxychloride (97.36 %), Azoxystrobin (94.55 %), Thiophanate methyl (94.15 %) and Fosetyl-AL (86.64 %) as most effective fungicides with significantly highest inhibition of mycelial growth of *P. aphanidermatum*. All the bioagents tested were found effective; whereas, *T. viride* (85.81 %), followed by *T. koningii* (83.09 %) and *T. harzianum* (80.40 %), *Aspergillus niger* (78.51 %) and *T. (Gliocladium) virens* (78.24 %) were most effective with highest mycelial growth inhibition. Of the 13 phytoextracts tested were found fungitoxic against test pathogen, but most promising with significantly highest mycelial growth inhibition were *A. indica* (86.33 %), followed by *A. sativum* (82.67 %) and *O. sanctum* (76.07 %). All 12 soil amendements tested against the test pathogen were fungistatic; however, Neem seed cake (73.87 %), followed by Castor cake (68.75 %), Mustard seed cake (66.32 %) were most effective with highest reduction in average mortality.

All the treatments tested *in vitro* under screen house conditions for integrated management of turmeric rhizome rot were found efficient in control of the disease, the treatments found most effective with highest disease reduction were: Metalaxyl (RT) + its drenching (85.37 %), followed by *T. viride* + *A. indica* leaf extract (RT) + Metalaxyl (SA) (74.54 %) and Carbendazim 12 % WP + Mancozeb 63 % WP (RT) + its drenching (73.30 %).

All the treatments imposed *in vivo* under field conditions for integrated management of turmeric rhizome rot were found effective in control of the disease with increase in rhizome yield. However, on the basis of pooled ICBR, the treatments found most effective and most economical in their order of merit were: T7 of Metalaxyl (RT) + its drenching, T10 of *T. viride* + *A. indica* leaf extract (RT) + Metalaxyl (SA) and T9 of

Carbendazim 12 % WP + Mancozeb 63 % WP (RT) + its drenching with ICBR of 4.54, 4.40 and 4.32 respectively.

All the ISR chemicals / elicitors tested as rhizome treatment and or soil application against turmeric rhizome rot were found effective; however, Chitosan (RT) + its drenching (97.25 %), followed by Salicylic acid (RT) + its drenching (96.07 %), Chitosan (RT) (94.29 %) and β -amino butyric acid (RT) + its drenching (93.56 %) were most effective with significantly highest reduction in average mortality.

None of the turmeric varieties evaluated during both the years were found free from rhizome rot. However, the variety Roma was found tolerant to the disease and rest of the test varieties showed moderately tolerant to susceptible reactions.

Title	-	Studies on bacterial wilt of ginger incited by <i>ralstonia solanacearum</i> (smith) yabuuchi in agro-climatic zones of maharashtra
Researcher	-	Kadam, R.V.
Research Guide	-	Jagtap, G.P.
Department	-	Plant Pathology
Subject	-	Plant Pathology
Degree	-	M.Sc
Thesis No.	-	17206
Krishikosh link	-	http://krishikosh.egranth.ac.in/handle/1/5810034163
Abstract	-	

Bacterial wilt caused by *R. solanacearum* is one of the most widely spread and destructive disease of ginger (*Zingiber officinale* Rosc.). Among the bacterial diseases infecting ginger crop, bacterial wilt caused by *Ralstonia solanacearum* (Smith) Yabuuchi, is one of the most destructive disease causing accountable qualitative and quantitative losses. Therefore, present investigations on *R. solanacearum* with the objectives *viz.*, survey, symptomatology, pathogenicity, cultural, morphological, biochemical and molecular variability amongst *R. solanacearum* isolates, effect of soil types on the growth of *R. solanacearum* physiological requirements of the pathogen, *in vitro* efficacy of fungicides, bioagents, botanicals, organic amendments and integrated disease management strategies were undertaken during 2015-16 to 2016-17 at VNMKV, Parbhani (M.S.), India.

The survey studies indicated that Bacterial wilt (*R. solanacearum*) disease is of common occurrence and widely distributed in the state of Maharashtra, with its maximum incidence during, *Kharif*, 2016-17 than that of *Kharif*, 2015-16 season. The pooled mean (*Kharif*, 2015-16 and 2016-17) results revealed maximum mean wilt disease incidence in Sangali district (24.14 %), followed by the districts *viz.*, Kolhapur (21.44 %), Satara (21.27 %), Nanded (17.83 %), Ratnagiri (16.51 %), Pune (16.27 %) and Hingoli (16.02 %); Whereas, it was minimum in the districts of Beed (8.93 %) and Solhapur (9.72 %).

Isolation was made from the soil samples by serially diluting the bacterial suspension in sterile distilled water and planting on TZC medium, purified and used for further studies. The pathogenicity test for *R.solanacearum* was proved by inoculating suspension of bacterial culture (5×10^8 cfu /ml) by pseudostem inoculation method. The

pathogenicity test attempted on susceptible ginger cv. Mahima in pot culture under screen house, clearly indicated that all the test isolates of *R. solanacearum* were pathogenic to ginger.

The typical symptoms of Bacterial wilt observed during survey were: The infected plants exhibit foliar yellowing which starts from the lower leaves and progress upwards. Infected plants were, downward curling of leaves and golden brown/rusty brown discoloration seen on older leaves. “Green wilt” the diagnostic symptom of the disease. Loss of leaf turgidity, older leaves were affected before the youngest leaves and plant wilted suddenly. Based on symptomatology, cultural, morphological and biochemical characteristics and pathogenicity test, the test pathogen was identified as *R. solanacearum* and its further identity was confirmed.

Cultural, morphological, biochemical and molecular studies revealed a wide range of variability of among the 10 isolates of *R. solanacearum*, which represented six agroclimatic zones of the Maharashtra state.

Among all the soil types (Red soil, Black soil and Sandy soil) tested, maximum colonies were found in Black soil (115 colonies) with irregular to round, dull white with slight pink center growth and pH, EC, Organic Carbon, CaCO₃, N, P₂O₅ and K₂O were 7.00, 0.335 dsm⁻¹, 4.87 g/kg, 44.50 g/kg, 315.00 kg/ha, 8.06 kg/ha, 394.88 kg/ha respectively. The temperature in the range of 25-35⁰C and pH in the range of 6.0 to 8.0 were found most favourable for better growth of *R. solanacearum* test isolates.

All the fungicides/antibiotics/bactericides, bioagents, botanicals and organic amendments evaluated *in vitro* were found antibacterial against *R. solanacearum*. However, of the antibiotic tested, Streptocycline (22.90 mm) and Tetracycline (12.46 mm), fungicides and bactericides tested, Calcium oxychloride (19.21 mm), Metalaxyl MZ (17.67 mm) and Copper oxychloride (11.43 mm); bioagents *viz.*, *P. fluorescens* (21.00 mm), *T. viride* (15.25 mm) and *Bacillus subtilis* (13.00 mm); botanicals *viz.*, *A. sativum* (11.90 mm), *C. longa* (11.42 mm), *A. cepa* (10.11 mm) and *D. stromonium* (9.71 mm) ; organic amendments *viz.*, Karanj cake (70.24 %), Poultry manure (66.64 %), Neem seed cake (63.70 %), Groundnut cake (53.28 %), Goat manure (52.71 %), FYM (45.64 %), Vermicompost (37.90 %) were most efficient with significantly highest inhibition zone of the test pathogen.

All the treatments imposed under field conditions for integrated management of Bacterial wilt of ginger were found efficient in control of the disease with increase in rhizome yield.

However, on the basis of pooled ICBR, the treatments found most effective and most economical in their order of merit were: T₃ (Pre-sowing rhizome treatment with 0.05% Streptocycline + 0.2% Copper oxychloride + Soil drench with 0.2% Bleaching powder and 0.1 % Metalaxyl MZ after disease inception). This was followed by T₄ (Pre-sowing rhizome treatment with 0.05% Streptocycline + 0.2% Copper oxychloride + Soil drench with 0.2% Bleaching powder after disease inception), T₁₀ (Rhizome treatment with Streptocycline @ 0.05 % + Soil application with *P.fluorescens* 100 gm/plot), T₅ (Pre-sowing rhizome treatment with 0.05% Streptocycline + 0.2% Copper oxychloride + Pre-sowing soil application with FYM enriched *T. harzianum* + *P. fluroscens* @ 1 kg each/ ton of FYM), T₂ (Pre-sowing rhizome treatment with 0.05% Streptocycline + 0.2% Copper oxychloride + Pre-sowing soil application with FYM enriched *Pseudomonas fluorescens* @5kg/ton FYM, T₁ (Pre-sowing rhizome treatment with 0.05% Streptocycline + 0.2% Copper oxychloride), T₉ (Rhizome treatment with Streptocycline @ 0.05 %) and T₇ (Pre-sowing soil application with Karanj cake (*P. glabra*)@ 100 gm /plot) with the ICBR, respectively of 2.55, 2.30, 1.95, 1.85, 1.80, 1.70, 1.65, respectively.