"FIELD TESTING OF HOMEOPATHIC DRUGS AGAINST EARLY BLIGHT (*Alternaria solani*) [Ell. And Martin] Jones and Grout OF TOMATO"

By

Miss. Pote Kalyani Ishwar

(Reg. No. 018/218)

DEPARTMENT OF PLANT PATHOLOGY AND AGRICULTURAL MICROBIOLOGY

POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI-413722, DIST-AHMEDNAGAR
MAHARASHTRA, INDIA
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A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH,
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In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

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MAHARASHTRA, INDIA

2021

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
there of, has not been submitted
by me or other person to any
other University or Institute
for a Degree or
Diploma

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This is to certify that the thesis entitled. **"FIELD TESTING OF HOMEOPATHIC DRUGS AGAINST EARLY BLIGHT (*Alternaria solani*) [Ell. And Martin] Jones and Grout OF TOMATO"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **PLANT PATHOLOGY** embodies the result of a piece of bonafide research work carried out by **Miss. POTE KALYANI ISHWAR** under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

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Place : MPKV, Rahuri. *(K. I. Pote)*
Date :

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LIST OF ABBREVIATIONS AND SYMBOLS

%	:	Per cent
@	:	At the rate of
^{o}C	:	Degree Celsius
CD	:	Critical difference
cm	:	Centimeter
ml	:	mililiter
ppm	:	parts per million
et.al.,	:	And other workers
ha	:	Hectare
hrs	:	Hours
i.e.	:	That is
±	:	Plus or Minus
t	:	tonne
mm	:	Millimeter
No.	:	Number
SE (±m)	:	Standard error of mean
Wt	:	Weight
MPKV	:	Mahatma Phule Krishi Vidyapeeth
viz.	:	Namely
g	:	gram
C.V.	:	Coefficient of Variation
Fig.	:	Figure (s)
in vitro	:	In Laboratory
Sr. No	:	Serial number
PDA	:	PotatoDextrose Agar
PDI	:	Per cent disease incidence
Conc.	:	Concentration
L	:	Litre
A	:	*Alternata*
EC	:	Emulsifiable concentration
CH	:	Centimental Hahnemaian
PGI	:	Post Graduate Institute
BOD	:	Biological Oxygen Demand
NS	:	Non significant

ABSTRACT

"FIELD TESTING OF HOMEOPATHIC DRUGS AGAINST EARLY BLIGHT (*Alternaria solani*) [Ell. And Martin] Jones and Grout OF TOMATO"

By

Ms. POTE KALYANI ISHWAR

A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

In

PLANT PATHOLOGY

POST GRADUATE INSTITUTE,

MAHATMA PHULE KRISHI VIDYAPEETH,

RAHURI-413 722

2021

Research Guide	**Dr. V. K. BHALERAO**
Department	**Plant Pathology and Agril. Microbiology**

Tomato (*Solanum lycopersicum* L.), native to the Andean region of South America, belongs to Solanaceae family, is one of the most common horticultural crops and cultivated throughout the world. It can be grown in a wide range of climates from tropical to temperate. It also can be cultivated under controlled conditions when outdoor temperatures are not favorable. It occupies a distinct position in the vegetable market due to it's high productivity and commercial value. Among the various diseases, Early blight (EB) is one of the dreadful diseases of tomato caused by *A. solani* and due to this it is economically very important disease in all over the world, including India and various regions of Maharashtra.

Most popular method to control diseases and pests is chemical control method used in whole world because of it's fast action against diseases and pests. It also require low dose and low cost as compare to other conventional methods. But the continued use of chemicals leads to the development of resistance in pathogens. Ultimately, the systemic use of these drugs leads to the persistence of chemical residues in the environment, proportionating low dosage toxicity and contaminating species across trophic levels. Hence, there is need to develop ecofriendly and economical strategies for the control of diseases and to reduce the dependence on the synthetic agrochemicals. Keeping in view these aspects present investigation was under taken entitled "Field testing of homeopathic drugs against early blight (*Alternaria solani*) [Ell. And Martin] Jones and Grout of tomato".

Disease sample were collected from the early blight infected tomato field of Department of Plant pathology and Agril. Microbiology, PGI, MPKV, Rahuri, from variety *Phule kesari* showing typical symptoms of early blight *viz.*, rounded brown to dark brown sunken with

concentric rings inside the spots produced target board effect on leaves, stem canker, etc.

Isolation and purification of the pathogen was done in the laboratory. Identification of fungus was made on the basis of morphological characters such as shape, size, septation of fungus in the culture medium and fungus was identified as *Alternaria solani*.

The pathogenicity was proved under glasshouse conditions by inoculating isolated culture by spore suspension spraying method by using Koch's postulate. Typical symptoms of early blight observed on test plant clearly after 7 days.

The pure culture of the fungus was examined regularly under the microscope for morphological characteristics *viz*., size, shape, conidia and septation. Fungus showed following morphology under microscopical studies:- Fungal mycelium was brown to grayish in colour but turned blackish on maturity. Mycelia was septate, branched and measured 2.45µ in width. Conidia were straight, sometimes slightly flexuous oblong or ellipsoidal in shape with tapering to form long beak or muriform shaped, light to dark brown in colour with 5 to 8 transverse septa and having 1 to 2 longitudinal or oblique septa.

Fourteen different selected homeopathic drugs of 30CH dilutions were evaluated at different concentrations under *in vitro* condition on. The efficacy of these 14 drugs are evaluated against mycelial growth of fungus *Alternaria solani* at 5% and 10% concentration on PDA media by Poison food technique and for tomato seed germination at 0.1% and 0.5% concentration by towel paper method. Eight homeopathic drugs that found most effective against mycelial growth of *Alternaria solani* at 5% and 10% concentration in the lab experiment were used for further investigation on field. Field experiment was carried out for evaluating efficacy of homeopathic drugs against early blight disease incidence and disease intensity and for evaluating effect of same homeopathic drugs on plant growth and yield at 5% and 10% concentration. Results given by homeopathic drugs *in vitro* against mycelial growth of *Alternaria solani* and *in vivo* (in field) against early blight disease incidence and disease intensity and for growth of tomato plants and yield compared with results given by recommended fungicide viz. tebuconazole 25% EC (1ml/L) over control.

In vitro, 10% concentration of homeopathic drugs found effective against mycelial growth of *Alternaria solani*. Eight homeopathic drugs of 30CH dilution *viz. Rhus texicodendron, Podophyllum pellatum, Natrum muriaticum, Aconitum napellum, Hepar sulphur, Arnica montana, Sulphur* and *Arsenicum album* effectively inhibits the mycelial growth at 10% concentration over control. *Arsenicum album* showed 97.7% mycelial growth inhibition over control at this concentration followed Sulphur (88.8% MGI), *Natrum muriaticum* (81.1% MGI) and *Arnica montana* (78.8% MGI). Whereas, recommended fungicide i.e. tebuconazole 25% EC showed 100% MGI which was nearly equal to *Arsenicum album.*

At 0.1% concentration of homeopathic drugs, *Natrum muriaticum* increased the seed germination over control by 20% followed by *Arnica montana* and *Sulphur* which increased the seed germination by 12% whereas, *Hepar sulphur* and *Arsenicum album* it increased by 3.9%. As concentration of drugs increased to 0.5%, it decreased the rate of germination in seed than it was at 0.1%.

Homeopathic drugs that was found most effective against mycelial growth of *Alternaria solani in vitro* used for evaluating effect on disease incidence and intensity over control in field condition. After third spraying, tebuconazole 25% EC (1ml/L) reduce the disease incidence and disease intensity by 70% and 75.78% respectively. While incase of homeopathic drugs 10% concentration found effective against early blight disease. At thisconcentration, after third spraying, *Arsenicum album* and *Sulphur* reduced the disease incidence and disease intensity most effectively next to the tebuconazole followed by *Natrum muriaticum* and *Arnica montana*. 38.44 to 40.35% disease incidence and 48.22 to 51.67% disease intensity reduced by *Arsenicum album* and *Sulphur* at 10% concentration *Natrum muriaticum* reduced disease incidence by 32.34% and disease intensity by 34.20%. while *Arnica montana* reduced disease incidence and disease intensity by 28.19 and 30.41% respectively.

It was observed that Sulphur and *Natrum muriaticum* increased the plant growth at maximum rate over control @ 10% concentration followed by Hepar sulphur and *Arsenicum album* followed by *Podophyllum pellatum* and tebuconazole 25% EC (1ml/L).

Among all homeopathic drugs, maximum yield over control @ 10% concentration was given by plants treated with *Arsenicum album* (29.77 t/ha) which is equally effective with tebuconazole 25% EC (32.04 t/ha) followed by sulphur (28.86 t/ha) and *Natrum muriaticum* (26.56 t/ha). It was combined effect of increase in seed germination, plant growth and effectively management of disease that leads to increase in yield over control.

In overall, for effective management of early blight disease and to increase the final yield of tomato in early blight disease condition *Arsenicum album* and sulphur found most effective followed by *Natrum muriaticum* and *Arnica montana.*

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.), native to the Andean region of South America, belongs to Solanaceae family, is one of the most common horticultural crops and cultivated throughout the world. It can be grown in a wide range of climates from tropical to temperate. It also can be cultivated under cover conditions when outdoor temperatures are not favorable. Mostly the plant grows upto 1-3 meters in height with a weak stem that often sprawis over the ground and vines over other plants. Determinant or indeterminant types of growth habit can be observed, depends on type of cultivar. Tomato occupy a distinct position in the vegetable market due to it‟s high productivity and commercial value. It is self pollinated crop.

Tomato is a warm-season vegetable crop but it also grown extensively in cool season. Average temperature required for its cultivation is 15° to 27°C. Sandy loam soils which is rich in organic matter are ideal for its cultivation. Howerver, it is grown in varied types of soil like sandy loam to clay loam and black soil to red soil having proper drainage.

Tomato is the world‟s second most consumed vegetable after potato [world atlas, 2019]. In the worldwide productin of tomatoes totaled 170.8 million tons. In India, tomato is one of the most popular and economically important crops. India ranks in second position in the total world production of tomato after China [FAOSTAT Database, 2017]. Tomato production in India in 2017-18 is 19.76 MT [NHB database, India]. The major Tomato producing States in the country are Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Chhattisgarh, Maharashtra, Bihar, Haryana, Uttar Pradesh, Telangana and Tamil Nadu. These States are account for 91concentration of the total production of the country. Five years (2012-13 to 2016-17) average tomato production in Maharashtra is 1.02 MT which shares for 5.5per cent of total tomato production in India [monthly report, tomato, HSD, India]. The major districts under tomato cultivation in Maharashtra are Nasik, Pune, Ahmednagar, Solapur, Nagpur, Chandrapur, Satara and Sangali.

Tomatoes are consumed in several ways. Fresh, mixed in other food items or processed and canned as sauce, ketchup, juice, salsa, paste, soup and pickled. Tomato is one of the most important „Protective food‟ because of it‟s special nutritive values. It has wide usage in Indian culinary tradition. It is the richest source of vitamin A and C and supplies a sufficient amount of the antioxidant lycopene pigment that helps to protect the body against cancer and heart disease [Bohm, F. et al, 2012, Van Breemen, R.B.and Pajkovic, N., 2008]. The pulp and juice of tomato is very digestible, promoter of gastric secretion and blood purifier. Tomato fruits contain about 95 percent water and 5 percent other component mainly carbohydrates and fibers. Because of its wide use and nutritional values, there is a high demand for both fresh market and processed tomato varieties. Higher production of tomato is therefore required to fulfill the ever-increasing demand.

Fungal, bacterial and viral diseases are serious among the important constrains in tomato crop production. Among the various diseases, Early blight (EB) is one of the dreadful diseases of tomato caused by *A. solani* and due to this it is economically very important disease in all over the world, including India and various regions of maharashtra [Chavhan et al. 2017, Kamble et al. 2009, Kumar and Kumar 2019]. As this disease damages leaves, petioles, stem and fruits, it can cause serious losses in crop yield if timely management of disease is not done.

Waraitch et al. (1975) recorded that the pathogen *A. solani* attacks the plants at all its growth stages. The disease on leaves, stem and fruits under favourable condition result in defoliation, drying of twigs and premature drop, depending upon its severity.

Datar and Mayee (1985) reported that *Alternaria solani* is an important pathogen causing early blight disease in tomato. It is very difficult to manage, due to its broad host range, extreme variability in pathogenic isolates and prolonged active phase of the disease cycle. The yield loss of tomato fruit was 78per cent recorded at 72per cent disease intensity of *A. solani* and each 1 per cent increase reduced tomato yield by 1.36 per cent.

Most popular method to control diseases and pests is chemical control method used in whole world because of it‟s fast action against diseases and pests. It also require low dose and low cost as compare to other conventional methods. So, it becomes very popular method in short time period all over the world after 1960‟s. The small number of cultivars with genetic resistance to this disease, associated with the high cost of seeds, results in the control with chemical products to those traditionally grown tomato varieties that are susceptible to the pathogen (Kurozawa and Pavan, 2005). But the continued use of chemical fungicides leads to the development of fungicide resistance in the fungal pathogen (Syed et al., 2018) and, in the absence of other control measures, to the re-emergence of virulence (Fisher et al., 2018). Therefore, in spite that the use of pesticides brought clear improvements in crop quality and quantity during more than half a century, their progressive inefficacy to treat some of the most harmful plant diseases requires the utilization of higher dosages each year (Syed et al., 2018). The use of fungicides heavily impacts on the microflora of agrarian ecosystems, destroying beneficial microbes, such as endophytic bacteria and fungi, as well as animals important for the quality of the soils (Syed et al., 2018). Ultimately, the systemic use of these drugs leads to the persistence of chemical residues in the environment, proportionating low dosage toxicity and contaminating species across trophic levels (Carvalho, 2006).

According to the Program for Analysis of Pesticide Residues in Food, 18 per cent of tomato samples analyzed were unsatisfactory due to the use of unauthorized pesticides and presence of pesticide residues above the acceptable limits in the produce (Anvisa, 2008). Also,

Use of such chemical pesticides on large scale frequently resulted in soil degradation, environmental pollultion and damage to wildlife.

Due to these reasons, now a days there has been growing interest in agricultural methods which are both economically and environmentally sound. It is a need to develop new strategies to manage tomato diseases with the use of natural pesticides such as homeopathic medicines.The emerging method of application of homeopathy in agriculture is currently being widely developed. Agrohomeopathy is a branch of homeopathy where homeopathic medicines including nosodes and auto-nosodes are used by farmers and gardeners on sick plants and trees and on soil. The research conducted by Saxena, Pandey, and Gupta, 1987 on the use of homoeopathic medicine against some pathogenic fungi that affect seed germination and homoeopathic treatments were found effective. It is an alternative to use of chemical fertilisers and pesticides in agriculture.. Homeopathy, science developed by Hahnemann for over 200 years, is an option with great potential in diseases control (Modolon et al., 2012). The remedies are derived from the animal, vegetable and mineral kingdoms. They include herbs, botanical medicines, drugs, extracts of animals and minerals. Extracts of diseased tissues are also used (nosodes). The concentrated medicines are in the form of liquid mother tinctures prepared by the maceration and extraction of suitable source materials in suitable alcohol/water mixtures. Homeopathic preparations are potentially effective and due to their ultra high dilution, are relatively cheap. They have no ecological side-effects, they are harmless and also easy to use by farmers. All these attributes make homeopathy optimally suited to the holistic approaches of organic and biodynamic agriculture. This new approach of applying homeopathic principles to agriculture can also be aimed at improving the nutritional properties and physiological and qualitative characteristics of plants, in addition to their resistance to biotic (insects and pathogens) and abiotic (physical and chemical damage) stress.

Alternaria solani is common disease causing pathogens of tomato in most of the tomato producing areas. Fungal pathogen may be externally or internally seed borne, extra or intra embryonal, or associated with the seeds as contaminants. As tomato crop is highly susceptible to disease early blight caused by seed borne fungi *Alternaria solani* and as tomato suffers from other seed borne organisms, these fungi are of considerable importance due to their influence on overall health, germination and final crop stand in field. The infected seeds may fail to germinate or can transmit disease from seed to seedling and/or from seedling to growing plant. It ceases the growth of plants in field condition and also by infecting fruits, damage the quality and quantity of final yield.

These aspects are taken into consideration in this investigation. To overcome these problems and to study the environmently sound method for managing this fungal disease by

using homeopathic drugs treatments as a solution on it, present topic is selected for research work with below objectives.

1. *In vitro* evaluation of homeopathic drugs against mycellial growth of *Alternaria solani.*
2. To evaluate the effect of homeopathic drugs on seed germination and plant growth.
3. To evaluate efficacy of homeopathic drugs against early blight of tomato under field condition.

2. Review of literature

Tomato is a most popular vegetable crop in the world due to its high nutritive and medicinal value, its taste, and also for its diversified use. There are various biotic factors that may responsible for limiting the yield of tomato. Among them fungal pathogens have high economical importance in the world including India and also in Maharashtra. Early blight of tomato is one of them which causes highly damage to tomato crop in early growth stages of crop which can be results in failure of whole crop if timely effective control measures will be not applied. Among various methods of controlling diseases and pests chemical method is most popular. But the continued use of chemicals leads to the development of resistance in pathogens. Ultimately, the systemic use of these drugs leads to the persistence of chemical residues in the environment, proportionating low dosage toxicity and contaminating species across trophic levels. Hence there is need to develop ecofriendly and economical strategies for the control of diseases and to reduce the dependence on the synthetic agrochemicals.

This review shows the importance of early blight of tomato in world and introduces basic principles of homeopathy and discusses the experimental evidences for the effectiveness of homeopathic drugs against diseases and considers its potential role in agriculture.

2.1 *Alternaria* (pathogen)

Gragon et al. (1975). reported a stem canker disease of tomato caused by *A. altenata* f. sp. *lycopersici*. The pathogen *Alternaria* plays a major role in causing leaf blight in tomato crop. Two species viz., *Alternaria solani* (Ellis and Martin, 1882), Jones and Grout, (1897) and *A. alternata* (Fries) Kessler (*A. tenuis)* have been observed to be an important pathogens on tomato from all over India.

Ellis and Martin (1882) was described the causal organism of early blight of tomato by for the first time from the drying leaves of tomato collected at New Jersey and named it as *Macrosporium solani*. In the year 1896-97, they described this pathogen critically and proposed new combination of nomenclature. Jones and Grout (1897) transferred it into the genus *Alternaria* because in one of their culture, spores were found in chains of two. Butler (1903) reported this pathogen for the first time in India on potatoes from Farukabad district of Uttar Pradesh.

Ellis and Gibson (1974) recorded in CMI description that *A. solani* may persist in infected debris in soil up to 3 years under temperate conditions and is known to be seed borne pathogen in tomato.

Patterson (1991) stated that chlamydospores of *A. solani* remained in soil along with tomato residue. These were responsible as a source of primary soil borne inoculum for infection of collar rot and early blight of tomato.

Pound (1951) observed that *Alternaria* has the ability to grow over a wide range of temperatures from 4 to 36°C and requires only a short wet period of at least four hours for successful infection (Vloutoglou and Kalogerakis, 2000).

Thomma (2003) reported that typically, weakened plant tissues, either due to stress, senescence, or wounding, are more susceptible to *Alternaria* infection than healthy tissues.

Nikam *et al*. (2015) evaluated fungicides, bioagents and botanicals *in vitro* and were found fungistatic / antifungal against *A. solani*. The bioagents *T.viride, A. niger* and *T. hamutum* and botanicals viz., *A. sativum, Z. officinale, E.globulus, A. sqamosa, L. innermis, A. cepa, A. vasica* and *C. longa* were found antifungal or fungistatic with significant inhibition of mycelial growth of test pathogen.

2.2 Symptoms induced by pathogen *Alternaria* species

Borksdale and Stoner (1973) observed the syndrome consisting of leaf spotting that leads to defoliation, stem cankers occasionally leading to stem and fruit rot caused by *Altemaria solani* in tomato.

Ellis and Gibson (1974) described the symptoms on foliage as small, dark, circular lesions, brown to dark brown becoming distinctly zonate at advance stages. Conidia are formed on necrotic lesions, later the spots become light coloured in centre. Under severe conditions the spot may enlarge rapidly, coalescing to give complete blighting and wilt condition. Stem lesion were roughly circular, sunken dark and zonate.

Wilson (1943) and Basu (1974) reported that floral infection and black rot of fruit of tomato are caused by *Alternaria solani*. The disease appears throughout the fruit growth and affects quality of fruits.

Waraitch et al. (1975) recorded that the pathogen *A. solani* attacks the plants at all its growth stages. The disease on leaves, stem and fruits under favourable condition result in defoliation, drying of twigs and premature drop, depending upon its severity.

Coffey et al. (1975) studied the effect of early blight disease caused by *A. solani* on shoot growth of young tomato plants. The changes in growth were related to the severity of infection with increasing inoculums which leads to premature leaf fall. Healthy leaves expanding soon after inoculation were markedly affected by the disease.

Gragon et al (1975) reported that *Altermaria alternata* f.sp. lycopersici was shown to be the cause of a serious stem canker disease of tomatoes. The fungus was a distinct pathotype capable of primary infection of leaves, stem and fruit of susceptible tomato cultivars.

Pearson and Hall (1975) studied that free moisture as dew deposition was essential for rapid germination of conidia in the absence of rainfall. However water soluble nutrient viz. glucose and fructose on the fruit surface dissolved in the dew stimulates the germination of conidia at 6-150C, causes infection and symptom development under field conditions. But

these conditions were not required for disease development under greenhouse conditions. Inoculation of ripe fruits frequently resulted in large sunken lesions whereas, inoculations of green fruit resulted in quiescent lesions that failed to enlarge after the fruit ripened. Sporulation was optimum at 270C and was inhibited below 15°C and above 33°c.

Datar and Mayee (1981) showed that *A. solani* could attack fruits in the green and ripe stages at the stem end growth cause cracks and other wounds.

Datar and Mayee (1985) reported that the early blight disease of potato was characterized by the appearance of brown to dark brown colour necrotic spots. Appearance of concentric rings inside the spots produced target board effect.

Reda et al. (1986) studied the response of three cultivars of tomato against *Alternaria solani* and showed fruits of redstone, Roma VF and marmande early were susceptible to rot caused by this pathogen. Plants and fruits of redstone were most susceptible. Diseased fruits weighed only half as much as healthy one, especially during the riped stage in Egypt.

Gleason et al. (1993) observed first initiation of symptoms on older leaves after fruit setting. Early blight caused dark brown leaf spot with concentric rings on tomato by *A. solani*.

Chaerani and Voorrips (2006) observed that *Alternaria solani* causes diseases on foliage (early blight), basal stems of seedlings (collar rot), stems of adult plants (stem lesions), and fruits (fruit rot) of tomato.

Pondkule (2018) studied that early blight caused by *A. solani* (Ellis and Martin) Jones and Grout is one of the most widely spread and destructive disease of tomato (Lycopersicon esculentum Mill). The pathogen induces damping-off, leaf blight, stem canker and fruit rot, which accounts for about 48-80 per cent fruit yield losses.. The typical symptoms of early blight observed during survey, pathogenicity test, and field experiments were circular, brown spots with concentric rings giving a target board effect, which later coalesced and caused blightening and defoliation, sometimes stem canker and under severe conditions rotting of fruits. Pathogenicity of the test pathogen was proved applying Koch‟s postulates Based on symptomatology, cultural and morphological characteristics, microscopic observations and pathogenicity test, the test pathogen was identified as *Alternaria solani* (Ellis and Martin) Jones and Grout and its further identity was confirmed. Studies on Field evalution of fungicides and bioagents against early blight of tomato (*A. solani*) disease indicated that, the significantly least disease incidence and intensity was recorded at 15 days after 3rd (last) spraying.

2.3 Recommanded technique – Tebuconazole 25 per cent EC

Ilhe et. al. (2008) investigated and recommended to undertake alternate sprays of fungicides mancozeb 75 WP @ 0.25 per cent (2 sprays) and Tebuconazole 25 EW @ 0.05 per cent (2 sprays) at 15 days interval starting from the appearance of the disease was found to be

most effective in controlling the disease early blight (*Alternaria solani*) and powdery mildew (*Leveillula taurica*) of tomato with better yield

Sukrutha Herle and Kamanna (2014) observed that out of twelve different fungicides tested in vitro against *Alternaria solani*, hexaconazole, tebuconazole, propiconazole, penconazole, combi products zineb 68 per cent + hexaconazole 4 per cent and captan 70 per cent + hexaconazole 5 per cent are equally effective and significantly superior with 100 per cent inhibition at all the concentrations which are on par with difenconazole (100% inhibition) at 0.1 and 0.15 per cent concentration, mancozeb (99.33% inhibition) at 0.25 per cent concentration, propineb (99.11% inhibition) at 0.25 per cent concentration. In case of field evaluation the best fungicide was found to be zineb 68 per cent + hexaconazole 4 per cent (21.50% PDI), which was on par with tebuconazole 25% EC (22% PDI) and captan 70%+ hexaconazole 5% (24.66% PDI). The highest yield (18.83 tonnes/ha) was obtained in zineb 68% + hexaconazole 4% with cost benefit ratio of 4.55, which is on par with tebuconazole 25% EC (18 t/ha) with incremental cost benefit ratio of 4.30 and captan 70% + hexaconazole 5% (17.83 t/ha) with B:C ratio of 4: 29.

Tuna (2014) investigated the effects of five different triazole compounds, triadimenol, tebuconazole, bitertanol, triadimefon, and paclobutrazol on the growth, macro-nutrition, antioxidative enzyme activities and other stress related parameters in *Solanum lycopersicum* L. (tomato) plants grown in greenhouse conditions under salt stress. With different triazoles, compound treatments overcame, to different extents, the adverse effects of NaCl stress on the above physiological and biochemical parameters. Triazole compounds treatment significantly enhanced the fresh and dry weight of shoots and roots as well as macro element contents of plant organs. Among the treatments, TRI, TEB, and TDM improved these parameters to a greater extent compared to other compounds. NaCl treatments remarkably increased the antioxidative enzyme activities at 5 per cent probability level when compared to control plants. In addition, exogenous application of different triazole compounds promoted this status. Triazol treatment increased the total chlorophyll, carotenoid, and relative water contents to a greater extent compared to salt-stressed plants. Compared to other triazoles, TDM and TEB treatments increased the above-mentioned parameters to a greater extent.

Arivalagan and Somasundaram (2017) reported the effect of triazole compound against stress in tomato plant. The combined drought stress with triazole treatments increased the photosynthetic pigments then reduced the ascorbic acid (AA), α-tocopherol, catalase (CAT), peroxidase (POX) and superoxide dismutase (SOD) activities, when compared to drought stressed plants. It can be concluded that the triazole treatment (Hexaconazole and Tebuconazole) partially mitigated the adverse effects of drought stress in L. esculentum.

Kuryata et. al. (2017) evaluated that the use of gibberelic acid and tebuconazole retardant during budding leads to increased plant productivity due to optimization of the structure and operation of the plants‟ leaf apparatus. It was established that both gibberelic and antigibberelic tebuconazole drug stimulated the formation and functioning of the photosynthetic apparatus of peppers and tomatoes. When using tebuconazole retardant there was a significant restructuring of the organization of leaf mezostructure: the leaves were thickened by chlorenchyma proliferation, there was an increase in the volume of columnar parenchyma cells and linear dimensions of spongy parenchyma leaf cell. Such a profound restructuring of the photosynthetic apparatus in plants under the actions of tebuconazole led to a significant increase in donor leaves function of peppers and tomatoes, which is an indicator of the growth of net productivity of photosynthesis – the highest among all the variants of the experiment. The results also show that increasing the chlorophyll phytocenotic index was more significant than the increase of leaf index: the tomatoes under the action of tebuconazole had a lower leaf index than in control options, but due to a higher chlorophyll index the crop productivity increased.Since during the fruiting period the costs of assimilates to the growth of vegetative organs are greatly reduced, optimization of photosynthetic apparatus in pepper and tomato plants led to the laying of more fruit per plant and increasing crop yield.

Rani et al. (2017). reported that the evaluation of chemical fungicides and plant extracts against *Alternaria solani* causing early blight of tomato revealed that Tebuconazole (25 EC) was the most effective fungicide followed by Difenconazole (25 EC).

2.4 The effect of homeopathic drugs on seed germination and plant growth

Weinstein *et al.* (1975) studied the effect of relatively low concentrations of SO2 (less than 20ppm) on the incidence and severity of bean rust and early blight of tomato. Sulphur dioxide affected bean rust and early blight of tomato under the conditions used in these experiments. The effect of SO2 on bean rust considered of a decrease in the incidence and severity of the disease and in the size and percentage germination of uredospores. These effects resulted from exposure of plants to SO2 before or after inoculation with the pathogen, but exposure before inoculation were more effective.

Bos (1978) showed retarted growth in *Alternaria solani* infected plants. Plant height and the number of leaflets/ plant were significantly decreased due to *Alternaria solani* infection. In this regards the reduction in all growth parameters development may be correlated with the disturbances in the supply or distribution of growth regulating hormones.

Rivas et. al. (1996) studied the effects 10 homeopathic treatments on spore germination of A. solani on tomato and wheat seed germination was studied. The most interesting results were obtained with Selenium 31c, which caused complete spore inhibition, and Cuprum 201,

203c.which reduced fungal germination by 40 and 50 per cent, respectively. Seedling growth was stimulated by sulphur 201, 203c.

Betti et al. (1997) investigated the effect of a 45x potency of *Arsenicum album* (As2O3) on wheat seedlings whose seeds had been previously poisoned with material dose of a same substance. The effect of homeopathic drug on stem growth was significant.

Hopkins C. R. (1998) observed that the homeopathically prepared medicines employed using germinability trials on *Lactuca sativa* (lettuce seeds) produced distinct biological effects. Statistical differences were noted between individual treatments with the Sulphur treated seed (supporting hypothesis one), with the Nitric acid treated seed (supporting hypothesis two), most notably with the Camphor treated seed a consistently faster germination than the above mentioned treatments occurred (supporting hypothesis three) and also between respective Sulphur/Camphor and Nitric acid/Camphor treated seed, however, only in certain of the cultivars (supporting hypothesis four). The results also provide evidence of the 3CH potency of the different treatments as having least effect with respect to germination promotion when compared to 9CH, 15CH and 30CH potency levels.

Brizzi et al., (2000) observed that Arsenicum album (As2O3) with different dilutions enhanced a seed germination in wheat.

Andrade et al., (2001) investigated the effect of homeopathic drugs on J. pectoralis growth, coumarin production and electromagnetic field. Weekly spraying (9) of 2.65 ml/plant of solution (10 drops/l water) on J. pectoralis of Phosphorus, Sulphur, Arnica montana, humic acid 3cH 70 per cent increased coumarin yield.

Bonato and Silva (2003) obseverved that the application of *Sulphur* improved the general conditions of the plants in practically all the studied variables, when compared with a control. The dinamizations 5 CH, 12 CH, 30 CH and 1 MCH showed better responses. The control and the dinamization 200 CH were the treatments that presented the most negative results. The results suggest that the homeopathy *Sulphur* can be an alternative to improve the productivity and appearance of commercial agricultural products, with substantial reduction in agricultural input.

Hamman et al. (2003) examined that effect of homeopathically prepared gibberellic acid (HGA3) on the germination performance of barley seeds. The effect of HGA3 (4- 200 CH) on seed germination and seedling development was compared to that of most commonly used form of gibberellic acid (GA3), 0.5G/L and control (distilled water). The extent and type of response was depend on the vigour level of seedlot. Treating seeds from three vigour group of HGA3 consistently resulted in larger seedlings. High – vigour seeds treated with HGA3 4, 30 AND 200CH germinated faster and roots of medium vigour treated with HGA3 15CH were

longer. As a plant model, germinating barley seeds successfully demonstrated the ability of HGA3 to produce biological a response.

Chapman (2004) investigated the effect of homeopathic medicines on plant growth, Plant size and weight in lettuce. Sulphur and Silicea in Homeopathic drugs, potentized water Treatments applied with plants on soil. He observed that Silicea and Sulphur 1LM influenced plant development.

Datta, (2006) reported that when mulberry plants were sprayed with Cina maritime, Cina MT diluted 1:40 and Cina 200c 1:20 4 times, every 3 days, with 10 ml of treatment, increased length and fresh weight of branches and roots, number of leaves/plant and foliar area.

Gangar (2007) proved that medicated water containing drugs of highest potency strongly influences the genetic processes of plants. It can accelerate germination process, can shorten cultivation period, can enhance yield as well as quality of cotton crop and also makes it possible to grow it during off-season.

Bonato et al (2009) analyzed the effects of homeopathic drugs Sulphur and Arsenicum album in growth variables and essential oil content of mint. Among the tested homeopathy drugs, Sulphur increased values of fresh and dry biomass more than Arsenicum album. Plant height increased by the two drugs and their respective dinamizations. Whereas Sulphur inhibited dry biomass production, except 6CH dinamization, it increased substantially mint plant‟s essential oil content. Arsenicum album presented the same behavior as Sulphur drug, with the difference that it increased the fresh biomass in 24 and 30CH dinamizations. Results suggest that Sulphur and Arsenicum album modify plant metabolism,especially by increasing secondary metabolism as occurs with essential oil contents.

Lensi et al (2010) observed that *Natrium muriaticum* had a significative effect of increasing the vegetable growth, mainly in the 6CH dilution when he was studied the action of *Natrium muriaticum* in dilutions 6 CH and 30 CH, in comparison with NaCl solution of 5 per cent, was also studied on *Phaseolus vulgaris.*

Toledo *et al.* (2010) reported that no treatment affected the germination of spores or the development of fungus colonies in the culture medium. In the first test, treatment 26cH differed from water in Tukey‟s test at 5 per cent but did not differed from diluted and agitated hydroalcoholic solution. In the second test, treatments 27cH and 28cH showed significant difference from both water and hydroalcoholic solution with an average control of disease of 57 per cent and 62 per cent respectively. The other 2 tests did nor exhibit any significant effect. There was no direct effect of the biotherapic on the fungus, but there was an effect on the severity of the disease.

Donadon et al. (2011) evaluated the effect of high diluted substances (high dilutions of homeopathic drugs) on the germination of radish seeds. He observed that *Arnica montana* 9x increased 5.9 per cent the seed germination when compared with distilled water.

Jager et al., (2011) observed that Arsenicum album, nosode, gibberellic acid, arsenic and other substances in various dilutions Water; succussed water Exposure to As2O3 48 h (intoxication), then plants were transferred to other containers with the treatments Arsenicum album and nosode, increased the growth rate (Number and foliar area, leave color) in *Lemna gibba.*

Mondal and Sukul (2012) observed that when seeds of *Vigna unguiculata* pretreated with *Natrium muriaticum* and afterwards stressed with NaCl, in the pretreated group there was an increase of seed germination compared with the control group stressed with the same substance.

Sukul *et al.* (2013) observed that in all the cases significant increase in morphometric as well as biochemical parameters were observed. In pigeon pea MH (Mallic Hydrazide) 30c showed comparatively poor performance in the growth promoting effect than the potentized CCC (clorocholine chloride). In Lady‟s finger all the potentized drugs produced significant improvement in plant growth and increased significantly water, chlorophyll and protein content in leaves. The FPLC study of cow pea leaf protein revealed that CCC 30c induced expression of some new proteins which might have played a role in growth and development of the plant. CCC200c significantly increased yields in rice under field conditions.

Molodon *et al.* (2014) investigated that the effect of high dilution preparations on the development of *Alternaria solani* mycelium, which causes early blight on tomato plants. Twelve bioassays were conducted under controlled conditions. Colony discs, 0.7 cm diameter, of A. solani were transferred into Petri dishes containing potato dextrose agar (PDA) or PDA + V8®(V8- vegetable juice, ®- Coefficient of variance) media. High dilution preparations of *Arsenicum album, Nitricum acidum* and Staphysagria at 6, 12, 25, 30, 50, 60, 80 and 100CH (centesimal Hahnemannian dilution scale) were applied either over the media or mixed in with it. Results showed that high dilution preparations have different effects on *A. solani* mycelium growth, according to the dynamization level. A. solani colonies were reduced by A. album 80 CH, by N. acidum 80 and 100 CH, and by Staphysagria 6, 30 and 60CH compared with the control when applied over PDA medium. Higher mycelium reduction was observed in the PDA assays when the treatments were applied over the medium than when incorporated into it. The differences among high dilution treatments were distinctly greater on the PDA medium than on the PDA þ V8w. Bioassay is a suitable method for screening high dilution preparations before studying them under field conditions.

Asha *et al.* (2014) concluded that a homeopathic drug *Thuja* has good inhibitory activity against the fungi causing keratitis, irrespective of the potencies. It is evident that no definite co-relation exists between various potencies of the same homeopathic drug with regard to their antimycotic properties.

Gama et al. (2015) observed that homeopathic drugs inhibited Aspergillus niger growth in vitro, in a dynamization-dependent way. Natrum muriaticum 5CH revealed the higher inhibition of 66 per cent, whereas sulphur 5CH yielded the lowest inhibition of 6.4 per cent.spore germination was reduced. disease severity was lower in treated plants, of 27.8 per cent using Ferrum metallicum 9CH than in control trials, of 73.6 per cent.findings suggest that homeopathic drugs could be a good strategy to control Aspergillus niger incidence in sisal plants.

Toledo *et al.* (2015) evaluated the action of different homeopathic drugs *Propalis, Sulphur,* and *Ferrum sulphuricum* at the dynamization of 6, 12, 30 and 60CH (Centimental Hahnemaian dilutions) on the control of *Alternaria solani* and on growth variables. *Sulphur* at 12 and 30CH, *Ferrum sulphuricum* at 6, 12 and 30CH and *Propalis* at all dilution reduced the AUDPC by 17 per cent to 49 per cent. *Sulphur* at 60CH and hydroalcoholic solution at 10 per cent had a systemic effect on resistance induction. *Propalis* at 30 and 60CH increased the volume of roots by 39 and 33 per cent, respectively, the fresh mass of shoots by 23 to 37 per cent, while at 60CH it increased by 59 per cent the mass of roots, which also occurred for *Ferrum sulphuricum* at 60CH (65% increment). These results indicate that homeopathic drugs can control early blight and increase the growth of tomato plants.

Toledo *et al.*(2016) evaluated *in vitro* fungitoxicity against *A. solani* by the homeopathic medicines *Propolis, Isotherapic of A. solani* and *Isotherapic of ash,* at 6, 12, 30 and 60CH (hahnemanian centesimal) dynamizations, and *Sulphur, Silicea terra, Staphysagria, Phosphorus, Ferrum sulphuricum and Kali iodatum* at 6, 12, 30 and 100CH dynamizations. Distilled water and 30 per cent hydroalcoholic solution were used as controls at 12, 30, 60 and 100CH dynamizations. Mycelial growth, sporulation and conidial germination of *A. solani* were evaluated. The results indicated that for mycelial growth only in *Sulphur* and *Staphysagria* 100CH showed suppressive effect compared to both controls. For sporulation, *Propolis* 6, 30 and 60CH and *Ferrum sulphuricum* 6 and 30CH caused inhibition and differed from both controls. *Isotherapic of A. solani* 6CH, *Isotherapic of ash* 6CH and *Ferrum sulphuricum* 30CH reduced spores germination of the pathogen. It was also found that distilled water at 60 and 100CH inhibited mycelium growth. These results indicate the potential of some homeopathic medicines for trials aiming to control the black spot disease in tomato crops.

Sen et al. (2018) observed that ultra high dilution of homeopathic medicines can be used safely for various purposes (Seed germination, betterment of soil health, growth of

seedlings, flowering, fruiting, protection against diseases and to overcome environmental stresses). But precautionary measures (proper selection of homeopathic drugs and its potency, proper dilution of drug with water) must be taken before use of these drugs.

2.5 *In vitro* efficacy of homeopathic drugs on mycellial growth of *Alternaria solani* and the efficacy of homeopathic drugs under field condition

Khatri and Singh (1975) presented a very short communication describes some remedies showing an inhibitory effect when mixed with TMV suspension and used as a spray treatment on tomato and goosefoot plants.

Khanna and Chandra (1976) obtained significant results in rot control of tomato, caused by *Fusarium roseum*, with the application of homeopathic preparations of *Kali iodatum* in 149CH and *Thuya occidentalis* in 87CH, in pre and post-harvest conditions. These authors evaluated the quality, palatability of fruits treated and cost of the treatment, concluding that there were practical and economic feasibility in the homeopathic treatment, besides the prophylactic and curative actions.

Khanna and Chandra (1978) evaluated the effect 0f 1-200 potencies of ten homeopathic drugs on the spore germination of *Pestalonia mangiferae,* the banana fruit rot causing fungi. He observed that under *In vivo* condition *Lycopodium clavatum* with potency 190 was effective to control the disease.

Chaube *et al*., (1978) reported that *Apis, Kali, Thuja, Sulphur* (30 and 200C potencies) showed strong toxicity against spore germination of *Cochliobolus miyabeanus, Haematonectria haematococca* and *Penicillium decumbens.*

Mishra (1983) evaluated nine drugs against A. niger a storage fungus found to be one of the most prevalent among the stored seeds of *Coriandrum sativum* and Cuminum cyminum. Results indicate that *Calcarea carbonicum*, potency 200 was most effective, inhibiting the appearance of *A. niger* on the surface of the seeds of coriander and cumin by 99.8 and 98.7 per cent respectively.

Sinha and Singh (1983) obtained significative results in the control of fungi producing aflatoxins in stored products, with *Sulphur* CH 200 which inhibited 100 per cent the growth of *Aspergillus parasiticus*. Other remedies (*Silicea terra* and *Dulcamara*) reduced the growth of the fungi with 50 per cent and the production of the toxin with 90 per cent.

Khanna and Chandra (1987) evaluated the effect of homeopathic drugs viz. *Arsenicum album, Ashwagandha, Blatta orientalis, Filix mas, Kali iodatum, Kali muriaticum, Lycopodium clavatum, Phosphorus, Thuja occidentalis and Zincum sulphuricum*. Nearly all the drugs inhibited the spore germination but their action was pathogen specific.

Khanna and Chandra (1989) obtained good results in the control of rot in mango, guava and tomatos, suppressing the spore germination and respiration of the fungi *Alternaria alternate, Colletotrichum gloeosporioides, Fusarium roseum* and *Gloeosporium psidii*.

Wilson *et al*. (1991) reported that the number of bacterial and fungal antagonists have been found that can effectively control post harvest rots of peaches, citrus, apples, grapes and tomatoes. These antagonist have various modes of action that includes antibiosis and/or competition for nutrients and space. The commercialization of some of these antagonists to control post harvest decay of fruits and vegetable appeared to be feasible and may present an alternative to synthetic pesticides.

Chuarasia J. P.and Vyas K. M. (1997) observed the remarkable efficacy of homeopathic drugs for checking the leaf rot (lesion) development. *Apis meliphica*, *Bryonica*, *Arnica Montana* were found to be most efficacious amongst all the tested homeopathic drugs. A complete control of leaf rot disease was shown by *Apis meliphica* at 6, 30, 200 and 1000 potency. Dua (1986) has also reported the antifungal activity of *Apis meliphica* against *Alternaria solani*.

Rolim et al. (2000) demonstrated a reduction of powdery mildew of tomato by *Kali iodatum* 100CH, in greenhouse, and increase in number of leaflets by biotherapic obtained from the pathogen *Oidium lycopersici*.

Rolim et al (2001) observed that in apple seedlings, two sprays of *Staphysagria* 100 CH at intervals of 12 days reduced powdery mildews 256 caused by *Podosphaera leucotricha*.

Rolim (2005) observed that *Staphysagria* in the 30 CH potency for tomato plants, in greenhouse and reduced the severity of early blight, as well as with *Phosphorus* 30 CH and isotherapics of *A. solani* in 30 and60 CH.

Fonseca et al. (2006) observed significant effect on tannin content in leaves and roots of medicinal plant *Porophyllum ruderale* with only one application of *Sulphur*, *Natrum muriaticum*, *Kalium phosphoricum*, *Calcarea carbonica*, *Silicea terrea* and *Magnesium carbonicum*, an dynamization 4CH, concluding that homeopathy in plants of *Porophyllum ruderale* can reduce the tannin content, reducing the astringency and increasing the palatability of leaves.

Carneiro et al. (2007) observed that the biotherapics of *Alternaria solani* in dynamizations 26, 27 and 28CH reduced the severity of the early blight disease in tomato plants cultivated in greenhouse.

Betti et al (2008) concluded that on the control of dark leaf spot caused by *Alternaria brassicicola* in cauliflower made by As2O3 DH 35 reduced significantly the infection on cauliflower heads compared to control.

Boff *et al.* (2009) conducted two field experiments to study the efficacy of homeopathic preparations for managing pests and diseases in organic farming systems of tomato crops. In the first experiment, different genotypes were sprayed equally with Silica 60c to evaluate yield and specific responses to pathogens (*Alternaria solani, Phytophthora infestance*). In the second experiment, potatoes were sprayed with different treatments (homeopathic potencies or propalis extract) and evaluated for yield and intensity of pests and diseases with respect to controls. Thuja 60c gave the best results, but no preparation significantly differed from another. Nevertheless, the homeopathic treatment were found to be good, in an organic farming system, as the standard Bordeaux mixture, and without any residual effect.

Trebbi *et al*. (2008) reported that in the preliminary screening of homeopathic treatments, the best disease control was obtained by As (*Arsenic trioxide*), which induced a reduced infection of about 20 per cent. Growth chamber experiment results confirmed the significant effect in disease control of As in the second experiment (infection level reduction vs. control of about s40%). A reduction of 15-25 per cent, but not significant, was obtained with bent (Bentonite); Cu (Copper oxiclorure) at all concentrations and BABA (β-aminobutyric acid) significantly reduced disease severity. In the field trial, disease assessments on cauliflower heads, performed in 3 successive times, significant reduction of disease symptoms for As, bent. and Cu 3 g/l, with a relative efficacy vs. control of 46, 42, 45 per cent, respectively.

Toledo et al. (2009) observed that all propolis-based treatments interfered with the development disease, so that, in these treatments, 14 days after inoculation of the pathogen, disease severity was lower than in controls with hydroalcoholic solution and water distilled. This indicates the potential of homeopathic propolis solutions for controlling black spot on tomato.

Toledo et al. (2009) evaluated the effect of *Sulphur* and *Ferrum sulphuricum* in the control of the early blight on tomato plants. The results showed that *Sulphur* in 12 and 30CH minimized the severity of disease in ten days after the inoculation with the fungus *Alternaria solani*, and 14 days after inoculation for 6 and 30CH. *Ferrum sulphuricum* in 12 and 60CH reduced the severity in ten days and in 12 and 30CH to fourteen days, but was not observed induction of systemic resistance.

Meinerz et al. (2010) observed increase in peroxidase activity in plants of tomato treated with three applications, in intervals of 72 hours, of *Propolis, Sulphur* and *Ferrum sulphuricum* in 6, 12, 30 and 60CH. In this case, *Propolis* 30CH overcame the other treatments when compared the sixth leaf treated and inoculated with *Alternaria solani*, with a seventh leaf only inoculated, showing systemic character to the treatment.

Monteiro *et al*. (2010) studied the effect of the biotherapic on the fungus was evaluated through the percentage of germinated spore under microscope and the growth of the colonies in

a culture medium. In which treatments were used as a biotherapic 26CH, 27CH, 28CH, 29CH and 30CH; sterilized distilled water; and diluted and agitated hydroalcoholic solution. The effect of biotherapic on development of the disease was evaluated in four experiments in greenhouse. Result obtained as no treatment affected the germination of the spore and development of the fungus colonies in the culture medium. In the first test, treatment 26CH differed from water in Tukey‟s test at 5 per cent but did not differed from diluted and agitated hydroalcoholic solution. In the second test, treatments 27CH and 28CH showed difference from water and both hydroalcoholic solution. With an average control of disease of 57 per cent and 62 per cent respectively. The other 2 tests did not exhibit any significant effect. They concluded that there was no direct effect of the biotherapic on the fungus, but there was an effect on the severity of the disease.

Toledo *et al*. (2011) reported that the homeopathic is low cost alternative to chemical fungicides, easy to use by farmers and how it is used in high dilutions, presenting an irrelevant environmental impact. So, this review aims to demonstrate the potential of homeopathy as a tool to control plant pathogens and its contribution for a sustainable agriculture.

Molodon et al. (2012) studied the effect of homeopathic and high dilution preparations on pests and diseases management of tomato crop under organic production system. The treatments consisted of homeopathic preparations *Staphysagria*, *Arsenicum album*, *Sulphur*, *Arnica montana*, high dilution preparations of *Solanum lycopersicum* and *Solanum aculeatissimum*, at the decimal (DH) or centesimal (CH) scale of hahnemanian high dilution. The preparation *Arnica montana* 12DH increased the tomato yield under field conditions. In greenhouse, the high dilution preparation of tomato at 12DH completely suppressed the septoria leaf spot and drastically reduced the same disease at 24DH.

Patil and Suryawanshi (2014) observed that *Nux vomica* shows higher PCE (50%) when used individually while Sulphur 30 CH was effective showing maximum PCE i.e. 84.45 per cent when used in mixture with mancozeb and fallowed by *Cina, Rhus toxicodendron, Arnica montana, Sanguinaria canadensis, Tarentula hispana* and Selenium in strawberry out of total nineteen homeopathic drugs against *Alternaria alternata* which causes fruit rot in strawberry.

Singh et. al. (2014) observed that The all five drugs viz., Belladonna, Bryonia, Colchicum, Colocynth and Lathyrus suppressed the growth of *A. flavus.* But Belladonna was found to be most effective drug on growth and aflatoxin production.

Dawar et. al. (2015) investigated that homeopathic drugs, *Thuja occidentalis* and *Natrum muriaticum* drugs was showed zone of inhibition against *Macrophomina phaseolina* and *Fusarium oxysporum* at 0.1% while *Rhizoctonia solani* was not inhibited by any of the homeopathic drug. Seed treatment with *T. occidentalis* at 0.1 per cent significantly improves

growth parameters in millet plant while root infecting fungi were reduced by using both drugs at 0.1 per cent. Chlorophyll content was increased by using both homeopathic drugs. In case of wheat plant, both drugs enhanced growth parameters, chlorophyll contents and reduced root infecting fungi.

Trebbi et al. (2016) observed that that ultra high dilutions of arsenic (where no more molecules of this substance are present) were effective in all the experiments, inhibiting spore germination by 60.0 per cent, controlling fungal disease(Dark leaf spot of cauliflower caused by *Alternaria brassicola*) in *in planta* experiments (relative efficacy of 42.1%), and, in field trial, decreasing the mean infection level in cauliflower heads by 45.7 and 41.6 per cent in artificially inoculated and naturally infected plants, respectively.

3. MATERIALS AND METHODS

The present studies on "field testing of homeopathic drugs against early blight (*Alternaria solani*) [Ell. And Martin] Jones and Grout of tomato" were carried out during kharif season of 2019-20 in the Department of Plant Pathology and Agrilcultural Microbiology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. The details of materials used and the methodology followed during the course of investigation are described here under.

3.1 Materials

3.1.1 Source of isolation

The infected leaves samples of tomato were collected for isolation of pathogen from the infected field of Department of Plant Pathology and Agrilcultural Microbiology, PGI, MPKV, Rahuri, from tomato variety *Phule kesari.*

3.1.2 Laboratory instruments and equipments

Various laboratory instruments used during the study were autoclave, laminar air flow unit, biological oxygen demand incubator (BOD), binocular research microscope, refrigerator, electronic and physical balance, ocular, ordinary as well as microphotography cameras, etc.

3.1.3 Glasswares

Different types of Qualigens and Borosil brand glasswares used during studies were conical flask, Petriplates, test tube, glass rods, slides, cover slips, funnels, beakers, measuring cylinder, pipettes, spirit lamps, desiccators etc.

3.1.4 Culture media

The common laboratory media i.e. Potato Dextros Agar (PDA) was used for isolation of organism responsible for causing disease in tomato plants and pure culture of isolated organism was maintained on PDA medium for further investigation.

A) Potato Dextrose Agar media

1. Potato (peeled) : 200 g
2. Dextrose : 20 g
3. Agar agar : 20 g
4. Distilled water : 1000 ml

3.1.5 Chemicals

The chemicals used for preparation of media were of analytical grades purchased from standard firms like M/S. E Merk (India) private Ltd., Mumbai and M/S Glaxo laboratories (India) Pvt. Ltd., Mumbai.

3.1.6 Homeopathic drugs

In all 14 different Homeopathic drugs formulations were taken for study.

Table 1. Homeopathic drugs of 30CH dilutions used in present investigation.

Sr. No.	Drugs	Use as a medicine for humans
1.	*Rhus texicodendron*	To treat sour throat, arthritis
2.	*Pulsatilia nigricans*	Treatment of food poison, backache
3.	*Podophyllum pellatum*	Useful against intestinal worms, snakebite
4.	*Cina*	Treatment of stomach pain, parasites
5.	*Lycopodium clavatum*	Top remedy for liver ailments
6.	*Nux vomica*	Helps in nausea, sour burping
7.	*Dulcamera*	Effective in bone pain
8.	*Colosynthesis*	Treatment of neuralgic pain
9.	*Natrum muriatum*	Commonly used for headache
10.	*Aconitum napellum*	Remedy for burning sensation
11.	*Hepar sulphur*	Antibiotic
12.	*Arnica Montana*	Treatment of acne, rashes, sprain
13.	*Sulphur*	Treatment of conjunctivitis
14.	*Arsenicum album*	Anti inflammatory

3.1.7 Tomato seeds and seedlings

The tomato seeds were collected from Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri and from collected seeds, seedlings were grown on raised bed nursery prepared on the field of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri.

3.1.8 The different miscellaneous materials used for conducting research

Inoculation needle, foreceps, cover slips, micro slides, spirit lamp, cotton, Mercuric chloride ($HgCl_2$), polyethyne bags, blotting papers, cork borer, labels, stickers, glass marking pencils, distilled water, sterilized water, scale, test tube stands, hand sprayers, knapsack sprayer, other field instruments, etc.

3.2. Experimental details

3.2.1 *In vitro* evaluation of homeopathic drugs

The *In vitro* experiments were conducted in laboratory of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, Mahatma Phule Agricultural University, Rahuri during the kharif season of 2019- 2020.

3.2.1.1 Details on *In vitro* evaluation of homeopathic drugs

Design : Completely Randomized Design (CRD)

Replication 3

Treatments 16

3.2.1.2 Treatment details

Number of treatments : 14 homeopathic drugs + tebuconazole 25% EC+ control

Concentration of homeopathic drugs used:

1. For mycelium growth inhibition test : 5% and 10%.
2. For seed germination test : 0.1% and 0.5%

Poison food technique was used for *in vitro* evaluation of 14 different homeopathic drugs along with recommended chemical fungicide and absolute control at two graded levels of concentrations *viz*. 5 and 10 per cent. The PDA medium was fortified with homeopathic drugs and chemical fungicide and inoculated at 28˚C in BOD incubator, observations were recorded at 7^{th} day.

It was found that out of these 14 , 8 treatments were effective under *In vitro* condition. So, these 8 treatments were used for further investigation under field condtion.

Effective treatments found *In vitro* are given below

1. *Rhus texicodendron*
2. *Podophyllum pellatum*
3. *Natrum muriatum*
4. *Aconitum napellum*
5. *Hepar sulphur*
6. *Arnica Montana*
7. *Sulphur*
8. *Arsenicum album*

3.2.2 Field experiment

The field experiment was conducted on the experimental field of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri in kharif season of 2019.

3.2.2.1 Geography and Climate

Geographically, the Mahatma Phule Krishi Vidyapeeth, Rahuri is situated between 19˚47‟ and 19˚57‟ North latitude and 74˚19‟ and 74˚32‟ East longitude. The altitude above mean sea level is 495 to 569 meter of Arabian sea. This tract is lying on the eastern side of Western ghat which falls under rain shadow area. Climatologically, this area falls in the scarcity zone (semi-arid tropics) with annual rainfall ranging between 307 and 619 mm. The average annual rainfall is 520 mm. The rainfall is erratic and ill distributed in 15 to 45 rainy days in different years. Out of total rainfall, about 50 per cent is received from South west monsoon (June to September), while the rest from North-East monsoon (October and November). The annual mean maximum temperature was 17.2˚C with a range between 3˚C and 18˚C. The mean relative humidity in morning and evening was 59 and 35 per cent, respectively. Agro-climatically the location is in the drought prone areas of Maharashtra state, chatacterised by low, erratic rainfall with less rainy days coupled with long dry spells.

3.2.2.2 Land preparation

The land selected for experimental purpose was ploughed and two harrowing were given. The appropriate quantity of farm yard manure (FYM) was uniformely spread all over the land before preparatory tillage operation. The soil was brought to fine tilth condition. The experiment was carried out in kharif 2019 in RBD design with three replications. The gross area was 4R.

3.2.2.3 Layout and plan

Location	: PGI farm, Central campus, MPKV, Rahuri
Year	: kharif 2019
Design of experiment	: Randomized Block Design (RBD)
Number of replications	03
Variety	: *Phule kesari*
Area under experiment	: 4 R
Plot size	: 2m× 2m
Spacing	: 60cm × 30cm

3.2.2.4 Treatment details

Number of treatments : 14 homeopathic drugs + tebuconazole 25% EC + control

Concentration of homeopathic drugs used:

1. For field spraying : 5%, 10%,

Control: Without treatment

Recommanded technique:

Tebuconazole 25% EC –1ml/L of water.

14 treatments with different concentration tested for their efficacy under laboratory condition. It was found that out of these 14, 8 treatments were effective under *In vitro* condition. So, these 8 treatments were used for further investigation under field condtion.

Effective treatments found under *In vitro* are already given above in *In vitro* experiment details.

3.3 Methodology

3.3.1 Collection of disease sample

The diseased sample of tomato leaves exhibiting typical leaf spot symptoms of *Alternaria solani* were collected from field of Plant Pathology farm, Post Graduate Institute, Mahatma Phule Krishi Vidypeeth, Rahuri, from tomato variety *Phule kesari*. The samples were used for isolation of *Alternaria solani*.

3.3.2 Isolation of the pathogen

Isolation of pathogen from leaves with diseased symptoms was done on potato dextrose agar medium by applying tissue isolation method. The collected leaves samples were cleaned

with tap water followed by air drying. The infected portion of leaves were separated and cut into small pieces. Four pieces were disinfected by surface sterilization with 1:1000 $HgCl_2$ solution for 5 second followed by three washing with sterilized water in order to remove traces of corrosive sublimate. These small pieces of infected leaves were transferred aseptically to the sterilized petriplates containing potato dextrose agar medium. These plates were then incubated in BOD incubator at (27 ± 1˚C). The plates were critically observed for the typical growth of fungus. The fungal colonies were then transferred on potato dextrose agar slants for further investigations.

3.3.3 Microscopic observation of fugal growth for identification of the pathogen

Fungi isolated from diseased samples was identified on the basis of morphological characters observed under microscope.

3.3.4 Pathogenicity test

Pathogenicity test was carried out for identification and confirmation of microscopical observations of isolated pathogen.

In this test, tomato plant was grown in pot filled with sterile soil in controlled condition. 1 day before inoculation of isolate in test plant, humid condition was prepared for plant by spraying distilled water and pot was kept in closed condition. On the next day, during morning, spore suspension prepared from isolated fungus was sprayed on plant and again kept in closed condition. Control was maintained by spraying the plants with only sterile distilled water. After 5-6 days, typical symptoms of early blight started to observe. Gradual changes in plant symptoms was recorded.

Reisolation was made from infected plant and the culture thus obtained was compared with original culture to confirm the identity and pathogenicity of pathogen.

3.3.5 Maintenance of pure culture

Pure culture of fungal pathogen was maintained on Potato Dextrose Agar slant under aseptic condition for further study.

3.3.6 *In Vitro* evaluation of Homeopathic drugs at different concentrations against *Alternaria solani*

Flasks of capacity 250ml containing 100ml of PDA media each separately was sterilized and 19ml and 18ml of media was poured in sterilized petri plates and 1ml and 2ml of one homeopathic drug was added in those plates respectively for 5 and 10 per cent concentration of homeopathic drugs respectively before solidification of the media. A 4mm disc of pure culture of *Alternaria solani* was taken and then was inoculated to the plates after media solidified. Used the same procedure for all 14 homeopathic drugs upto 3 replications of each concentration of each drug. Chemical check was prepared by pouring 20ml of PDA media in the sterilized petriplate from the flask containing 100ml of media with 100ppm tebuconazole

25% EC. 3 replications for chemical check was prepared using same procedure and 4mm disc of pure culture of *Alternaria solani* was inoculated in all 3 plates of chemical check asceptically. Control was prepared by inoculating the fungal disc in PDA plate without any homeopathic drug. The plates was kept at 25-28˚C and the fungus was allowed to grow. The observations were recorded after seven days when the fungus in control plates was grown completely.

An observation on linear mycelial growth of test pathogen was measured and percent inhibition of test pathogen was calculated by applying the formula given by (Arora and Upadhay, 1978) as follows:

$$\text{Percent inhibition} = \frac{C - T}{C} \times 100$$

Where,

C = growth of the test fungus in (mm) untreated control plates

T = growth of the test pathogen in (mm) treated plates

3.3.7 Testing the efficacy of Homeopathic drugs on seed germination of tomato at 0.1 and 0.5 per cent concentration

Fourteen homeopathic drugs for seed germination of tomato seeds were evaluated. 0.1 and 0.5 per cent concentrations of homeopathic drugs was prepared by taking 10ppm and 50ppm of homeopathic drug in 9.99 ml and 9.95ml of distilled sterilized water in sterilized test tubes respectively. Ten seeds were dipped separately for each in 0.1 and 0.5% concentration of homeopathic drugs for 8 hours. After 8 hours, seeds were kept on sterilized germination paper. The seeds were covered with another germination paper. Procedure repeated for 3 replications. Then plates were kept at room temperature for 7 days for germination. The control was prepared by just soaking of seeds in water for 8 hours and was kept the seeds on wet germination paper. Percent germination was recorded after 7 days.

3.3.8 Evaluation of the efficacy of homeopathic drugs against plant disease incidence and intensity and testing the effect on plant growth in tomato plants under field condition

Homeopathic drugs which were found effective under *In vitro* condition were tested on tomato plants infected with early blight disease caused by *Alternaria solani* under field condition for plant disease incidence and intensity by following method.

3.3.8.1 Growing of tomato seedlings on nursery bed under field condition

For the growing of tomato seedlings, a well aerated seed bed was prepared on the field. Mixture of soil and FYM (2:1) was added to the seed bed. Seeds of tomato were sown on nursery bed and watered. Timely watering to the seed bed was done till proper height and

strength achieved by seedling for transplanting. After 30 days seedlings were became ready for transplanting.

3.3.8.2 Transplanting of tomato seedlings on field

In previously well prepared field, 30 days old seedlings were transplanted on ridges in the plots. After well establishment of seedlings in the plots, further treatments were carried out.

3.3.8.3 Preparation of *Alternaria solani* spore suspension for spraying of spore suspension on seedlings

For preparation fungal spore suspension, aqueous suspension of fungal spores were prepared by pouring sterile distilled water on to agar plates containing sporulated cultures followed by gently scraping the agar surface. The spore suspension was passed through four layers of sterile muslin cloth to remove mycelial fragments. *Alternaria* solani spore suspension was poured in small hand sprayer. One day before, watering of plants was carried out. Well prepared spore suspension was sprayed on the tomato plants in next morning and in evening.

After incidence of early blight disease on tomato plants, observations were recorded for plant disease incidence and intensity on following basis.

3.3.8.4 Studies on plant disease incidence and intensity in tomato plant before spraying of homeopathic drugs

Obsevations of disease incidence and disease severity (intensity)

The observations of disease incidence were recorded from all plants in per plot treatment in the field trial at 15 days interval. The calculations were made by using the following formula:

$$\textbf{Percent Disease Incidance} = \frac{\textbf{Number of infected plant}}{\textbf{Total number of plants}} \times 100$$

The percent disease severity was calculated. In each plot ten plants were randomly selected and for measuring disease severity at lower, middle and upper crop canopies were observed and evaluated individually using 0-9 rating scale (Mayee and Datar,1986) based on leaf area covered by blight as mentioned below in table.

Table 2 : Rating scale (grade) used for Early blight of tomato

Rating scale (Grade)	Disease Severity	Level of resistance / Susceptibility
0	No symptom	Immune
1	Small circular, scattered, brown spots, covering 1% or less of the leaf area	Highly Resistant
3	Spots enlarging, dark brown in colour covering 1 to 10 % of leaf area and infection on the lower most leaves of the plant	Resistant
5	Spots enlarging, dark brown in colour covering 11 to 25% of leaf area and infection on the lower most leaves of the plant	Moderately Resistant
7	Spots dark brown in colour covering 26 to 50% of leaf area and covering one third of the plant	Susceptible
9	Spots uniformely dark brown, coalescing, covering 50% or more leaf area and severe infection on all leaves.	Highly Susceptible

Further these scales were converted to percent disease severity using formula given by Ayyangar (1928):

$$\textbf{Disease intensity (\%)} = \frac{\textbf{Sum of all numerical ratings}}{\textbf{Total number of observations} \times \textbf{Maximum rating grade}} \times 100$$

3.3.8.5 Studies on plant disease incidence and intensity after spraying of homeopathic drugs on tomato plants

The tomato plants grown in plots on the field were sprayed with homeopathic drugs which were found effective in laboratory against pathogen at 5 and 10 per cent concentration Spraying was done for 3 times at 15 days interval. First spraying was given on occurrence of disease.

Plant disease incidence and intensity was recorded at 15 days after of each spraying by measuring disease incidence and disease intensity by using methods previously mentioned in point no. „3.3.8.4".

3.3.8.6 Efficacy of Homeopathic drugs on plant growth under field condition

Homeopathic drugs which were found effective under laboratory test used to test efficacy on plant growth parameter under field condition. 8 drugs were found effective against pathogen. 15 days after completion of third spraying, effects of different homeopathic drugs on growth parameters of diseased plants were recorded by measuring height of plant in cm, no.of branches and no. of leaves in individual plant which were previously treated with homeopathic drugs for studies of plant disease incidence and intensity. Effect on yield was also recorded at the time of harvesting of fruits.

All methodologies that used for evaluating effect of homeopathic drugs under field condition were also used for tebuconazole 25% EC in a same way at 1ml/L concentration

3.4 Statistical Analysis

The statistical analysis was done as per the method given by Panse and Sukhatme (1985). The per cent values were transformed into arcsine values. The standard error (SE), critical difference (C.D) and Covariance (CV) were worked out and results obtained were compared statistically.

4. RESULTS AND DISCUSSION

Plant diseases caused by different types of organisms specially by fungal pathogens leads to large economical losses in all over the world. To control such noxious diseases most popular and commonly used method is chemical fungicides application. But the continued use of chemical fungicides leads to the development of fungicide resistance in the fungal pathogen (Syed Ab Rahman et al., 2018). The use of fungicides heavily impacts on the microflora of agrarian ecosystems, destroying beneficial microbes, such as endophytic bacteria and fungi, as well as animals important for the quality of the soils (Syed Ab Rahman et al., 2018). Ultimately, the systemic use of these drugs leads to the persistence of chemical residues in the environment, proportionating low dosage toxicity and contaminating species across trophic levels (Carvalho, 2006). It also destroy the soil productivity.

Due to these reasons, now a days there has been growing interest in agricultural methods which are both economically and environmentally sound.

By keeping this view, the present studies were carried out under the heading of " Field testing of homeopathic drugs against early blight (*Alternaria solani*) [Ell. And Martin] Jones and Grout of tomato" undertaken during Kharif 2019- 20 on tomato vaiety *Phule kesari*. The results obtained on all these aspects are being interpreted and discussed here in the context to the references available.

4.1 Isolation and microscopic examination of pathogen

Pathogen was isolated from the tomato plant leaves collected from field of department of plant pathology, PGI, MPKV, Rahuri, from tomato plant variety Phule kesari showing typical symptoms of early blight disease using standard method of tissue isolation. Pure culture of fungal pathogen was maintained on Potato Dextrose Agar slant under aseptic condition and preserved in refrigerator for further studies. Fungi isolated from diseased samples was observed under microscope for morphological study of isolated fungus.

Isolated fungus showed following morphology under microscopical studies:- Fungal mycelium was brown to grayish in colour but turned blackish on maturity. Mycelia was septate, branched and measured 2.45µ in width. Conidia were straight, sometimes slightly flexuous oblong or ellipsoidal in shape with tapering to form long beak or muriform shaped, light to dark brown in colour with 5 to 8 transverse septa and having 1 to 2 longitudinal or oblique septa.

These observations agreed with the description given by Ellis in 1971 for *A.solani.* Kaul and Saxena (1988) observed the brown to greyish colored hyphae of *A. solani.* Pondkule (2018) carried out similar procedure for isolation and purification and microscopic examination of *A. solani.*

4.2 Pathogenicity test

Pathogenicity test was carried out for identification and confirmation of microscopical observations of isolated pathogen.

In this test, typical symptoms of early blight was showed by test plant of tomato *var* Phule kesari. Typical symptoms were observed on leaves, stems and petioles under controlled green house condition. Similar symptoms were also observed earlier on tomato plant *var Phule kesari* under field condition. Pathogen reisolated from test plant grown under green house condition and again observed under microscope. Typical morphological characters of *Alternaria solani* were observed under microscope as ealier observed.

Hence identification of early blight of tomato causing fungus i.e. *Alternaria solani* was confirmed and Pathogenicity was proved by using Koch‟s postulate.

Nikam et al. (2015) and Pondkule (2018) proved Pathogenicity of A. solani successfully under controlled condition of green house on tomato plant *var. Pusa ruby*.

4.3 In Vitro evaluation of homeopathic drugs at different concentrations against mycelial growth of *Alternaria solani*

Effect of different homeopathic drugs treatments on mycelial growth of *Alternaria solani* under *In Vitro* condition is presented in Table 3.

The data on percent inhibition of mycelial growth of *Alternaria solani* was recorded at 7^{th} day after treatment. It has been found that 10 per cent concentration was most effective than 5 per cent in all homeopathic drugs.

Data in Table revealed that at 5 per cent concentration all treatments inhibited the mycelium growth in some extent as compare to control. Among all homeopathic drugs, *Arnica Montana* showed maximum mycelial growth inhibition i.e. 60 per cent which is at par with *Arsenicum album* i.e. 58.8 per cent followed by *Rhus texicodendron* and *Hepar sulphur* i.e. 50 per cent which are at par with *Sulphur* i.e. 48.8 per cent. Minimum mycelial growth inhibition at 5 per cent was observed in *Colosynthesis* i.e. 20 per cent, among all homeopathic drugs whereas in control maximum mycelial growth was observed (0% inhibition). Rest of treatments showed percent inhibition ranged from 30- 43.3 per cent. Whereas, complete mycelial growth inhibition was observed in chemical check i.e. tebuconazole (25% EC) at 1ml/L concentration i.e. 100 per cent.

At 10 per cent concentration the resuts revealed that all homeopathic drugs significantly inhibited the mycelial growth over control. Among all these homeoapathic drugs, in *Arsenicum album* maximum inhibition was observed i.e. 97.7 per cent which was at par with chemical check i.e. tebuconazole (100% inhibition). In *Sulphur* 88.8 per cent mycelium growth inhibiton was observed followed by *Natrum muriaticum* (81.10%) which is at par with *Arnica Montana* i.e. 78.8 per cent followed by *Hepar sulphur* (77.70%) which was at par with *Aconitum napellum* (76.6%) and *Podophyllum pellatum* (75.50%) followed by *Rhux texicodendron* (74.40) which was at par with

Table 3. Effect of homeopathic drugs treatment on mycelial growth (mm) of *Alternaria solani*

Sr. No.	Treatment details	For 5% concentration		For 10% concentration	
		Mycelial growth on 7th day (mm)*	Inhibition over control(%)	Mycelial growth on 7th day (mm)*	Inhibition over control(%)
1	*Rhux texicodendron*	45	50	23	74.40
2	*Pulsatilia nigricans*	59	34.4	33	63.30
3	*Podophyllum pellatum*	63	30	22	75.50
4	*Cina*	48	46.6	33	63.30
5	*Lycopodium clavatum*	48	46.6	24	73.30
6	*Nux vomica*	51	43.3	34	62.30
7	*Dulcamera*	51	43.3	25	72.20
8	*Colosynthesis*	72	20	27	70.00
9	*Natrum muriatum*	63	30	17	81.10
10	*Aconitum napellum*	63	30	21	76.60
11	*Hepar sulphur*	45	50	20	77.70
12	*Arnica Montana*	36	60	19	78.80
13	*Sulphur*	46	48.8	10	88.80
14	*Arsenicum album*	37	58.8	2	97.70
15	Tebuconazole 25% EC (1ml/L)	0	100.00	0	100.00
16	Control	90	0	90	0
	SE (m)±	**1.00**	-	0.77	-
	CD @ 0.05	**2.89**	-	2.25	-
	CV	**3.39**		5.37	-

***:-** Mean of three replications

Lycopodium clavatum (73.30%) and *Dulcamera* (72.20%) followed by *Colosynthesis* (70%) followed by *Pulsatilia nigricans* which are at par with *Cina* (63.30%) and *Nux vomica* (62.30%).

In this investigation, 100% inhibition of fungal pathogen was obtained from chemical check i.e. tebuconazole (25% EC). Similar result on tebuconazole efficacy against *Alternaria solani* was obtained by G. Sukrutha Herle and B. C. Kamanna (2014) in which they observed

that the fungicide tebuconazole tested *in vitro* against *Alternaria solani* was effective and significantly superior with 100 per cent inhibition at all the concentrations.

Result is also in agreement with result given by Rani et al. (2017). He reported that the evaluation of chemical fungicides and plant extracts against *Alternaria solani* causing early blight of tomato, revealed that Tebuconazole (25 EC) was the most effective fungicide.

In the results of present studies, *Arsenicum album* was most effective homeopathic drug that inhibited mycelial growth of fungus at 10 per cent concentration This result is consistent with result of Molodon *et al.* (2014).He investigated that the effect of high dilution preparations on the development of *Alternaria solani* mycelium, which causes early blight on tomato plants. *A. solani* colonies were reduced by *A. album* 80 CH, compared with the control when applied over PDA medium. Khanna and Chandra (1987) evaluated the effect of different homeopathic drugs including *Arsenicum album.* In his results, nearly all the drugs inhibited the spore germination but their action was pathogen specific. He obtained good results in the control of rot in mango, guava and tomatos, suppressing the spore germination and respiration of the fungi *Alternaria alternate, Colletotrichum gloeosporioides, Fusarium roseum* and *Gloeosporium psidii*.

Next to the *Arsenicum album*, Suphur found effective to inhibit pathogenic fungal growth. This result is contradictory with investigation of Gama et al. (2015) in which he told that sulphur 5CH yielded the lowest inhibition of 6.4 per cent spore germination was reduced in *Aspergillus niger* growth *in vitro*, in a dynamization-dependent way but the result is similar in case of *Natrum muriaticum* in which he revealed the higher inhibition of 66 per cent, at 5CH.

Result in case of sulphur is in agreement with Toledo *et al.*(2016). His results indicated that for mycelial growth *A. solani* in *Sulphur* showed suppressive effect compared to both controls. Chaube *et al*., (1978) reported the strong toxicity of *Sulphur* (30 and 200C potencies) against spore germination of *Cochliobolus miyabeanus, Haematonectria haematococca* and *Penicillium decumbens.* Sinha and Singh (1983) obtained significative results in the control of fungi producing aflatoxins in stored products, with *Sulphur* CH 200 which inhibited 100 per cent the growth of *Aspergillus parasiticus*. Rivas et. al. (1996) found the sulphur effective on spore germination of *A. solani* on tomato.

4.4 Evaluation of effect of seed treatment with homeopathic drugs on percent seed germination in tomato seeds

Effect of seed treatment with homeopathic drugs on percent seed germination is presented in Table 4.

Observations were recorded on 7th day after treatment. Results given in the Table revealed that different homeopathic treatments showed diffferent results. Germination was

increased by some homeopathic treatments over control while other didn‟t show any effect on germination whereas some treatments reduced germination over control at different concentrations. But at 0.1 per cent concentration some of treatments had increased the germination percent in tomato seeds while in case of 0.5 per cent concentration all of treatments were ineffective or inhibits germination of seeds.

At 0.1 per cent concentration, maximum increased in seed germination over control was observed in *Natrum muriaticum* (20%) followed by *Arnica Montana* (12%) and *sulphur* (12%) which were at par with *Hepar sulphur* and *Arsenicum album* that increased germination by 3.9 per cent. *Rhux texicodendron, Pulsatilia nigricans, Podophyllum pellatum* and *Aconitum napellum* had no effect on germination was observed which were at par with *Cina, Lycopodium clavatum, Nux vomica, Colosynthesis* and *Dulcamera* that reduced germination of seeds by 8, 12, 15.99 and 20 per cent respectively.

At 0.5 per cent concentration, maximum increased in seed germination over control was observed in *Natrum muriatum* (by 8%) which was at par with *Hepar sulphur* (by 3.9%) while no effect on seed germination was observed in *Pulsatila nigricans, Podophyllum pellatum, Dulcamera, Arnica Montana* over control. *Aconitum napellum* and *sulphur* reduced germination by 3.9 per cent which were at par on *Rhux texicodendron, Cina* and *Arsenicum album* that reduced the germination by 8 per cent. Which were at par on *Lycopodium clavatum* and *Nux vomica that* reduced germination by 12 per cent whereas *Colosynthesis* reduced germination over control by 15.99 per cent.

In these results, *Natrum muriaticum, Arnica Montana and sulphur* found most effective at 0.1 per cent concentrations. In case of *Natrum muriaticum,* this result is similar to Mondal and Sukul (2012). They observed that when seeds of *Vigna unguiculata* pretreated with *Natrium muriaticum* and afterwards stressed with NaCl, in the pretreated group there was an increase of seed germination compared with the control group stressed with the same substance.

Followed by *Natrum muriaticum, Arnica Montana* was most effective at 0.1 per cent concentration This result is consistent with Donadon et al. (2011) results in which he observed that *Arnica montana* 9x increased 5.9 per cent the seed germination when compared with distilled water in radish seeds.

Sulphur found as effective as *Arnica montana* at 0.1 per cent concentration This is in agreement with Hopkins C. R. (1998). He observed that the homeopathically prepared medicines employed using germinability trials on *Lactuca sativa* (lettuce seeds) produced distinct biological effects he found increase in germination in Sulphur treated seed. *Arsenicum album* at 0.1 conc showed effectiveness at some extent. Brizzi et al., (2000) observed that *Arsenicum album* (As2O3) with different dilutions enhanced a seed germination in wheat.

Table 4. Effect of seed treatment with homeopathic drugs on per cent seed germination

Sr. No.	Treatment details	At 0.1 % concentration		At 0.5% concentration	
		seed germination (%)*	Increased in seed germination over control (%)	seed germination(%)*	Increased in seed germination over control (%)
1	*Rhux texicodendron*	83.33 (66.11)	0	76.66 (61.19)	-8
2	*Pulsatilia nigricans*	83.33 (66.11)	0	00 (0.00)	0
3	*Podophyllum pellatum*	83.33 (66.11)	0	83.33 (66.11)	0
4	*Cina*	76.66 (61.19)	-8	76.66 (61.19)	-8
5	*Lycopodium clavatum*	76.66 (61.89)	-8	73.33 (59.18)	-12
6	*Nux vomica*	73.33 (58.98)	-12	73.33 (58.98)	-12
7	*Dulcamera*	66.66 (54.76)	-20	00 (00.00)	0
8	*Colosynthesis*	70 (56.97)	-15.99	70 (56.97)	-15.99
9	*Natrum muriaticum*	100 (90)	20	90 (71.53)	8
10	*Aconitum napellum*	83.33 (66.11)	0	80 (63.90)	-3.9
11	*Hepar sulphur*	86.66 (68.82)	3.9	86.66 (68.82)	3.9
12	*Arnica Montana*	93.33 (77.69)	12	83.33 (66.11)	0
13	*Sulphur*	93.33 (77.69)	12	80 (63.40)	-3.9
14	*Arsenicum album*	86.66 (68.82)	3.9	76.66 (61.19)	-8
15	Control	83.33 (66.11)	0	83.33 (66.11)	0
	SE (m)+	**3.56**	**-**	**2.56**	**-**
	CD @ 0.05	**10.35**	**-**	**7.43**	**-**
	CV	**9.2**		**8.06**	

***:-** Mean of three replications**.** Figures in parentheses are angular transformed values.

Gangar (2007) proved that medicated water containing drugs of highest potency strongly influences the genetic processes of plants. It can accelerate germination process, can shorten cultivation period, can enhance yield as well as quality of cotton crop and also makes it possible to grow it during off-season. Sen et al. (2018) observed that ultra high dilution of homeopathic medicines can be used safely for various purposes (Seed germination, betterment

of soil health, growth of seedlings, flowering, fruiting, protection against diseases and to overcome environmental stresses). But precautionary measures (proper selection of homeopathic drugs and its potency, proper dilution of drug with water) must be taken before use of these drugs.

4.5 Evaluation of efficacy of homeopathic drugs on plant disease incidence and intensity

Efficacy of homeopathic drugs on early blight plant disease incidence and intensity in tomato plant is presented in tables. Observations were recorded at 15 days interval for 3 times i.e. upto 3rd spraying plant disease incidence and intensity was recorded at two concentrations i.e. at 5 and at 10 per cent concentration

4.5.1 Bioefficacy of homeopathic drugs on plant disease incidence and intensity at 5 per cent concentration

Efficacy of homeopathic drugs on early blight plant disease incidence and intensity in tomato plant at 5 per cent concentration upto theree periodically spraying at 15 days interval is presented in following tables.

4.5.1.1 plant disease incidence and intensity after first spraying of homeopathic drugs

Plant disease was measured in two ways i.e. disease incidence and disease intensity. Before spraying of drugs, in all plots, percent disease incidence and percent disease intensity was measured that ranged from 15.44 to 17.72 per cent and 12.94 to 15.01 per cent respectively. There was non significant difference was observed in between them. After first spray, observations were recorded on 16th day. Observations are presented in Table 5.

Percent reduction in disease incidence over control ranged from 2.11 to 39.46 per cent. In all treatments, maximum percent reduction in disease incidence over control at 1ml/L concentration was observed in tebuconazole (39.46%) which was used as a recommended technique in present investigation. Whereas, in homeopathic drugs, at 5 per cent concentration, maximum percent reduction in disease incidence over control was observed in *Arsenicum album*. Minimum percent reduction in disease incidence over control was found in *Rhus toxicodendron* (2.11%). Among all homeopathic drugs, minimum disease incidence was observed in the plants sprayed with *Arsenicum album* (28.84%) which was at par with *sulphur* (29.16%), *Natrum muriaticum* (29.27%), *Arnica Montana* (29.76%), Hepar sulphur (30.55%), *Aconitum napellum* (30.57%) and *Podophullum pellatum* (30.45%). Maximum disease incidence among all homeopathic drugs was observed in *Rhus texicodendron* (28.87%) which was at par with untreated control plot in which 32.13 per cent disease incidence was found. Whereas, least disease incidence was observed in recommended technique i.e. tebuconazole (19.45%) over control at 1ml/L concentration.

Table 5. Efficacy of homeopathic drugs (5% Concentration) on disease incidence and disease intensity of early blight (*Alternaria solani)* of tomato *var Phule kesari* after first spray

Sr. No.	Treatments	Disease incidence* (%)		Reduction over control (%)	Disease Intensity* (%)		Reduction over control (%)
		Before spray	after first spray		Before spray	after first spray	
1	*Rhux texicodendron*	17.50 (24.67)	31.45 (34.09)	2.11	14.09 (21.99)	29.00 (32.56)	0.82
2	*Podophyllum pellatum*	16.41 (23.87)	30.95 (33.79)	3.67	13.27 (21.35)	28.18 (32.04)	3.62
3	*Natrum muriatum*	17.72 (24.83)	29.27 (32.73)	8.90	13.91 (21.83)	26.74 (31.12)	8.54
4	*Aconitum napellum*	15.89 (23.46)	30.57 (33.54)	4.85	12.70 (20.85)	27.96 (31.88)	4.48
5	*Hepar sulphur*	16.29 (23.79)	30.55 (33.53)	4.91	15.01 (22.67)	27.72 (31.75)	5.19
6	*Arnica Montana*	15.98 (23.54)	29.76 (33.04)	7.37	12.98 (21.08)	27.52 (31.62)	5.88
7	*Sulphur*	16.43 (23.88)	29.16 (32.66)	9.24	13.13 (21.21)	26.23 (30.78)	10.29
8	*Arsenicum album*	16.69 (24.09)	28.84 (32.46)	10.23	13.91 (21.86)	25.92 (30.58)	11.35
9	Tebuconazole 25% EC (1ml/L)	15.44 (23.12)	19.45 (26.15)	39.46	10.86 (19.24)	16.38 (23.86)	43.98
10	Control	16.51 (23.96)	32.13 (34.51)	0.00	12.94 (21.07)	29.24 (32.72)	0.00
	SE (m)+	**0.90**	**0.49**	**-**	**0.90**	**0.73**	-
	CD @ 0.05	**NS**	**1.46**	**-**	**NS**	**2.19**	-
	CV	**6.54**	**2.59**	**-**	**7.29**	**4.10**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

Percent reduction in disease intensity after first spray ranged from 0.82 to 43.98 per cent. Maximum percent reduction in disease intensity was observed in recommended technique i.e. tebuconazole (43.98%). Whereas, among homeopathic drugs, maximum percent reduction in disease intensity was observed in *Arsenicum album* (11.35%) and minimum percent reduction in disease intensity was observed in *Rhus texicodendron* (0.82%). Among all homeopathic drugs, *Arsenicum album* (25.92%) showed minimum disease intensity at 5 per cent concentration which was at par with all other homeopathic treatments and with control too. In other homeopathic treatments disease intensity was observed as *Sulphur* (26.23%), *Natrum muriatum* (26.74%), *Arnica Montana* (27.52%), Hepar sulphur (27.72%), *Aconitum napellum* (27.96%), *Podophyllum pallatum* (28.18%) and *Rhus texicodendron* (29%) where in

Table 6. Efficacy of homeopathic drugs (5% Concentration) on disease incidence and disease intensity of early blight (*Alternaria solani)* after second spray on tomato *var. Phule kesari*

Sr. No.	Treatment no.	Disease incidence after 2nd spray (%)*	% reduction over control	Disease intensity 2nd spray (%)*	% reduction over control
1	*Rhux texicodendron*	37.55 (37.77)	2.4	35.28 (36.42)	2.60
2	*Podophyllum pellatum*	37.28 (37.45)	3.90	34.52 (35.96)	4.74
3	*Natrum muriatum*	35.67 (36.27)	8.99	32.92 (34.99)	9.16
4	*Aconitum napellum*	37.05 (37.22)	4.90	34.05 (35.68)	6.04
5	*Hepar sulphur*	36.76 (37.20)	5.00	33.74 (35.49)	6.89
6	*Arnica Montana*	35.74 (36.56)	7.80	33.56 (35.38)	7.39
7	*Sulphur*	35.47 (36.16)	9.50	32.29 (34.61)	10.89
8	*Arsenicum album*	34.20 (35.77)	11.16	30.52 (33.51)	15.78
9	Tebuconazole 25% EC (1ml/L)	17.29 (24.54)	55.09	14.09 (22.01)	61.13
10	Control	38.50 (38.33)	0.00	36.24 (37.00)	0.00
	SE (m)+	**0.54**	**-**	**0.63**	-
	CD @ 0.05	**1.63**	**-**	**1.90**	-
	CV	**2.65**	**-**	**3.22**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

untreated control plot disease intensity of 29.24 per cent was observed. In tebuconazole (1ml/L), lowest disease intensity was observed i.e. 16.38 per cent among overall treatments.

4.5.1.2 Plant disease incidence and intensity after second spraying

Second spraying was carried out 15 days after of first spraying and plant disease incidence and intensity was recorded at 16th day. Observations are given in the Table 6.

Percent reduction in disease incidence after second spray ranged from 2.4 to 55.09 per cent. Maximum reduction in disease incidence was observed in tebuconazole (55.09%) at 1ml/L concentration Whereas, among homeopathic drugs, maximum reduction in disease incidence was observed in *Arsenicum album* (11.16%) and minimum percent reduction in disease incidence was observed in *Rhus toxicodendron* (2.4%). In all homeoapathic drugs, minimum disease incidence was observed in *Arsenicum album* (34.20%) which was at par with sulphur (35.47%), *Natrum muriaticum* (35.67%), *Arnica montana* (35.74%), Hepar sulphur (36.76%) and *Aconitum napellum* (37.05%) followed by *Podophyllum pellatum* (37.28%)

which was at par with *Rhus toxicodendron* (37.55%) and control (38.50%). Whereas, recommended technique i.e. tebuconazole (1ml/L) was most effective treatment over control among all treatments after second spraying in which 17.29 per cent disease incidence was observed.

Percent reduction in disease intensity ranged from 2.6 to 61.13%. Maximum percent reduction in disease intensity over control was observed in tebuconazole i.e. 61.13 per cent with disease intensity 14.09 per cent. Whereas, minimum reduction in disease intensity over control was observed in *Rhus toxicodendron* (2.6%). In homeopathic drugs, *Arsenicum album* was most effective with disease intensity 30.52 per cent which was at par with Sulphur (32.29%), *Natrum muriaticum* (32.92%) and *Arnica montana* (33.56%). Next to these, Hepar sulphur showed 33.74 per cent disease intensity which was at par with *Aconitum nepallum* (34.05%), *Podophyllum pallatum* (34.52%), *Rhus texicodendron* (35.28%) and control plot (36.24%).

4.5.1.3 Plant disease incidence and intensity after third spraying

Data is given in Table 7. After recording the observations of second spraying, third spraying was carried out. After 15 days, observations of third spraying were recorded. In tebuconazole (25% EC), minimum disease incidence was observed (15.17%) followed by homeopathic treatment *Arsenicum album* (40.35%) which was at par with sulphur (41.21%). Next to these, *Natrum muriatum* (43.81%) which was at par with *Arnica Montana* (44.43%) followed by Hepar sulphur (46.37%) which was at par with *Aconitum nepallum* (46.81%), *Podophyllum pallatum* (47.64%) and *Rhus texicodendron* (48.76%). Percent disease incidence in control plot was at 50.57 per cent. Tebuconazole showed maximum percent reduction in disease incidence over control i.e. 70 per cent. Whereas, in case of homeopathic drugs maximum reduction in percent disease incidence was observed in *Arsenicum album* i.e. 20.20 per cent whereas, *Rhus texicodendron* showed minimum percent reduction in disease incidence over control i.e. 3.57 per cent.

In homeopathic drugs minimum disease intensity observed in *Arsenicum album* (36.68%) which was at par with Sulphur (37.72%) followed by *Natrum muriatum* (40.32%) which was at par with *Arnica Montana* (41.85%) followed by Hepar sulphur (43.96%) which was at par with *Aconitum nepallum* (43.69%), *Podophyllum pellatum* (44.86%), *Rhus texicodendron* (45.90%) and control (47.24%). In homeopathic drugs, maximum reduction in disease intensity over control was observed in *Arsenicum album* i.e. 22.35 per cent. Minimum disease intensity was observed in tebuconazole (14.93%) with maximum percent reduction in disease intensity over control (66%) at 1ml/L concentration.

Table 7. Efficacy of homeopathic drugs (5 % Concentration) on disease incidence and disease intensity of early blight (*Alternria solani*) of tomato *var Phule kesari* after third spray

Sr. No.	Treatment no.	Disease incidence after 3rd spray(%)*	reduction over control(%)	Disease intensity 3rd spray(%)*	% reduction over control
1	*Rhux texicodendron*	48.76 (44.27)	3.57	45.90 (42.63)	2.83
2	*Podophyllum pellatum*	47.64 (43.62)	5.79	44.86 (42.03)	5.03
3	*Natrum muriatum*	43.81 (41.42)	13.36	40.32 (39.40)	14.64
4	*Aconitum napellum*	46.81 (43.15)	7.43	43.69 (41.35)	7.51
5	*Hepar sulphur*	46.37 (42.90)	8.30	43.96 (41.51)	6.95
6	*Arnica Montana*	44.43 (41.78)	12.14	41.85 (40.29)	11.40
7	*Sulphur*	41.21 (39.92)	18.50	37.72 (37.87)	20.15
8	*Arsenicum album*	40.35 (39.41)	20.20	36.68 (37.25)	22.35
9	Tebuconazole 25% EC (1ml/L)	15.17 (22.91)	70.00	11.45 (19.75)	75.76
10	Control	50.57 (45.30)	0.00	47.24 (43.40)	0.00
	SE (m)+	**0.48**	**-**	**0.64**	-
	CD @ 0.05	**1.44**	**-**	**1.92**	-
	CV	**2.06**	**-**	**2.88**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

4.5.2 Bioefficacy of homeopathic drugs on plant disease incidence and intensity at 10 per cent concentration

Efficacy of homeopathic drugs on early blight plant disease incidence and intensity in tomato plant at 10 per cent concentration is presented in following tables. At 10 per cent concentration disease incidence and disease intensity was measured upto three periodically spraying at 15 days interval.

4.5.2.1 Plant disease incidence and intensity at 10 per cent concentration after first spraying of homeopathi drugs

Data for plant disease incidence and intensity at 10 per cent concentration after first spraying of homeopathic drugs is presented in Table 8.

In overall treatments, maximum percent reduction in disease incidence over control was recorded in tebuconazole (39.46%). Whereas, minimum percent reduction in disease incidence over control was found in *Podophyllum pellatum* (8.1%) and *Rhus texicodendron* (6.2%) and

Table 8 Efficacy of homeopathic drugs (10% Concentration) on disease incidence and disease intensity of early blight (*Alternria solani)* of tomato *var Phule kesari* after first spray

Sr. No.	Treatment no.	Disease incidence after 1st spray(%)*	reduction over control(%)	Disease intensity after 1st spray(%)*	Reduction over control (%)
1	*Rhux texicodendron*	30.11 (33.26)	6.2	28.38 (32.17)	2.9
2	*Podophyllum pellatum*	29.52 (32.89)	8.1	27.40 (31.55)	6.29
3	*Natrum muriatum*	25.57 (30.36)	20.41	22.59 (28.36)	22.74
4	*Aconitum napellum*	28.71 (32.38)	10.64	26.14 (30.74)	10.60
5	Hepar sulphur	26.80 (31.81)	13.45	24.29 (29.52)	16.92
6	*Arnica Montana*	26.42 (30.91)	17.73	22.87 (28.55)	21.78
7	Sulphur	23.78 (29.17)	25.98	19.36 (26.08)	33.78
8	*Arsenicum album*	22.70 (28.44)	29.34	19.18 (25.96)	34.40
9	Tebuconazole 25% EC (1ml/L)	19.45 (26.15)	39.46	16.38 (23.86)	43.98
10	Control	32.13 (34.51)	0.00	29.24 (32.72)	0.00
	SE (m)+	**0.38**	**-**	**0.38**	-
	CD @ 0.05	**1.18**	**-**	**1.14**	-
	CV	**2.13**	**-**	**2.28**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

in rest of the treatment percent reduction in disease incidence over control ranges from 10.64 to 29.34 per cent in which among all homeopathic drugs maximum percent reduction in disease incidence over control was observed in *Arsenicum album* i.e. 29.34 per cent. Minimum disease incidence i.e. 19.45 per cent was observed in tebuconazole (1ml/L). Among homeopathic drugs, minimum disease incidence was observed in *Arsenicum album* (22.70%) which was at par with sulphur (23.78%) followed by *Natrum muriaticum* (25.57%) which was at par with *Arnica Montana* (26.42%), followed by Hepar sulphur (26.80%) which was at par on *Aconitum napellum* (28.71%) and *Podophyllum pallatum* (29.52%). Maximum disease incidence over control was observed in *Rhus texicodendron* (30.11%). In control plot disease incidence was 32.13%.

Maximum disease intensity reduced by recommended technique i.e. tebuconazole (43.98%) over control. Whereas, in homeopathic drugs treatment, maximum reduction in

disease intensity over control was showed by *Arsenicum album* (34.40%) and minimum reduction in disease intensity over control was showed by *Rhus texicodendron* (2.9%).

Minimum disease intensity was observed in tebuconazole (1ml/L) plot i.e. 16.38 per cent followed by homeopathic drug *Arsenicum album* (19.18%) which was at par with Sulphur (19.36%), followed by *Natrum muriaticum* (22.59%) which was at par with *Arnica montana* (22.87%), followed by Hepar sulphur (24.29%) which was at par with *Aconitum napellum* (26.14%). Maximum disease intensity over control was observed in *Podophyllum pellatum* (27.40%) and *Rhus texicodendron* (28.38%) which were at par. Whereas, in control plot disease intensity was 29.24 per cent.

4.5.2.2 Plant disease incidence and intensity at 10 per cent concentration after second spraying of homeopathic drugs

Second spraying was carried out at 15 days after first spraying observations were recorded at 16th day of spraying. Data presented in Table 9.

Table 9. Efficacy of homeopathic drugs (10% Concentration) on disease incidence and disease intensity of early blight (*Alternria solani)* of tomato *var Phule kesari* after second spray

Sr. No.	Treatment no.	Disease incidence after 2nd spray(%)*	reduction over control(%)	Disease intensity after 2nd spray(%)*	reduction over control(%)
1	*Rhux texicodendron*	35.48 (36.54)	7.80	30.24 (33.35)	16.55
2	*Podophyllum pellatum*	35.11 (36.32)	8.80	29.28 (32.74)	19.20
3	*Natrum muriatum*	28.48 (32.23)	26.02	25.22 (30.13)	30.46
4	*Aconitum napellum*	31.51 (34.13)	16.98	28.25 (32.09)	22.04
5	Hepar sulphur	31.41 (34.07)	18.41	28.07 (31.98)	22.54
6	*Arnica Montana*	28.92 (32.51)	24.88	26.44 (30.92)	27.04
7	Sulphur	26.16 (30.74)	32.05	21.22 (27.41)	41.44
8	*Arsenicum album*	25.88 (30.56)	32.77	20.00 (26.55)	44.81
9	Tebuconazole 25% EC (1ml/L)	17.29 (24.54)	55.1	14.09 (22.01)	61.13
10	Control	38.50 (38.33)	0.00	36.24 (37.00)	0.00
	SE (m)+	**0.51**	**-**	**0.42**	-
	CD @ 0.05	**1.54**	**-**	**1.25**	-
	CV	**2.70**	**-**	**2.39**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

After second spraying maximum reduction in disease incidence over control was observed in tebuconazole (1ml/L) i.e. 55.1 per cent and minimum reduction in disease incidence over control was found in *Rhus texicodendron* (7.8%). Whereas, among homeopathic drugs, maximum reduction in disease incidence over control was observed in *Arsenicum album* (32.77%). In tebuconazole 17.29 per cent disease incidence was observed followed by *Arsenicum album* (25.88%) which was at par with Sulphur (26.16%) followed by *Natrum muriaticum* (28.15%) which was at par with *Arnica Montana* (28.92%) followed by Hepar sulphur (31.41%) which was at par with *Aconitum napellum* (31.51%). Maximum disease incidence was observed in *Podophyllum pallatum* (35.11%) and *Rhus texicodendron* (35.48%) which were at par with each other. In control plot disease incidence was 38.50 per cent.

After second spraying, reduction in disease intensity ranges from 16.55 to 61.13 per cent. Maximum reduction in disease intensity over control was observed in tebuconazole i.e. 61.13 per cent whereas minimum reduction in disease intensity over control was observed in *Rhus texicodendron* (16.55%). Among homeopathic drugs, maximum reduction in disease intensity over control was observed in *Arsenicum album* i.e. 44.81 per cent. Minimum disease intensity was observed in tebuconazole i.e. 14.09 per cent followed by *Arsenicum album* (20%) which was at par with Sulphur (21.22%) followed by *Natrum muriatum* (19.64%) which was at par with *Arnica montana* (26.44%) followed by Hepar sulphur (28.07%) which was at par with *Aconitum napallum* (28.25%) and *Podophyllum pallatum* (29.28%). Maximum disease intensity was observed in *Rhus toxicodendron* (30.24%). In control plot disease intensity was 36.24%.

4.5.2.3 Plant disease incidence and intensity at 10% concentration after third spraying of homeopathic drugs

After third spraying, observations for disease incidence was recorded at 16th day. Data is presented in Table 10.

After third spray, reduction in disease incidence over control was observed in between range of 8.2 to 70 per cent. Maximum reduction in disease incidence was showed by *Arsenicum album* (40.35%) and minimum reduction was observed in *Rhus texicodendron* (8.2%), among homeopathic drugs. Whereas, in tebuconazole, 70 per cent reduction in disease incidence over control was observed. In *Arsenicum album* plot minimum disease incidence was observed i.e. 30.16 per cent which was at par with Sulphur (31.13%) followed by *Natrum muriaticum* (34.23%) which was at par with *Arnica Montana* (36.31%) followed by Hepar sulphur (37.15%), *Aconitum napellum* (39.09%) and *Podophyllum pellatum* (43.25%). Maximum disease incidence was observed in *Rhus texicodendron* (46.41%). In control plot disease incidence was 50.57 per cent.

Table 10. Efficacy of homeopathic drugs (10% Concentration) on disease incidence and disease intensity of early blight (*Alternria solani)* of tomato *var Phule kesari* after third spray

Sr. No.	Treatment no.	Disease incidence after 3rd spray(%)*	reduction over control(%)	Disease intensity after 3rd spray(%)*	reduction over control(%)
1	*Rhux texicodendron*	46.41 (42.92)	8.2	38.84 (38.53)	17.80
2	*Podophyllum pellatum*	43.25 (41.10)	14.47	36.55 (37.18)	22.64
3	*Natrum muriatum*	34.23 (35.79)	32.34	31.09 (33.87)	34.20
4	*Aconitum napellum*	39.09 (38.68)	22.71	35.85 (36.76)	24.12
5	Hepar sulphur	37.15 (37.54)	26.54	35.13 (36.33)	25.64
6	*Arnica Montana*	36.31 (37.03)	28.19	32.88 (34.97)	30.41
7	Sulphur	31.13 (33.90)	38.44	24.47 (29.64)	48.22
8	*Arsenicum album*	30.16 (33.29)	40.35	22.84 (28.52)	51.67
9	Tebuconazole 25% EC (1ml/L)	15.17 (22.91)	70	11.45 (19.75)	75.78
10	Control	50.57 (45.30)	0.00	47.24 (43.40)	0.00
	SE (m)+	**1.56**	-	**0.81**	-
	CD @ 0.05	**4.68**	-	**2.42**	-
	CV	**7.77**	-	**4.55**	-

*:- Mean of three replications, Figures in parentheses are angular transformed values

Reduction in disease intensity over control was observed in between range of 17.80 to 75.78 per cent. Maximum reduction in disease intensity was found in tebuconazole (75.78%) at 1ml/L concentration followed by *Arsenicum album* (51.67%) whereas minimum reduction in disease intensity over control was observed in *Rhus texicodendron* (17.80%). In tebuconazole minimum disease intensity was observed i.e. 11.45 per cent followed by *Arsenicum album* (22.84%) which was at par on Sulphur (24.47%) followed by *Natrum muriaticum* (31.09%) which was at par with *Arnica montana* (32.88%) followed by Hepar sulphur (35.13%) which was at par with *Aconitum napellum* (35.85%) and *Podophyllum pellatum* (36.55%). Maximum disease intensity over control was observed *Rhus texicodendron* (38.84%). In control plot disease intensity was 47.24 per cent.

From the data present this investigation, it was observed that no one homeopathic drugs treatment found significantly effective at 5 per cent concentration, but 10 per cent concentration these treatments except *Podophyllum pellatum* and *Rhus texicodendron* found

more effective than at 5 per cent concentration and their effectivity was increased with increase in no. of spraying. Among all homeopathic drugs, *Arsenicum album* and sulphur found most effective over control against early blight disease of tomato followed by *Natrum muriaticum*, *Arnica Montana* at 10 per cent concentration Whereas, among overall treatment tebuconazole found superior.

Tebuconazole was found to be most effective to control early blight disease of tomato among all treatments used in this studies. This is result is similar to Ilhe et. al. (2008) in which he investigated and recommended Tebuconazole 25 EW @ 0.05% (2 sprays) at 15 days interval starting from the appearance of the disease to control the early blight (*Alternaria solani*) and powdery mildew (*Leveillula taurica*) of tomato with better yield.

In case of homeopathic drugs, findings of this studies i.e. successfully reduction of the disease by these drugs are in agreement with various findings by different scientists.

Results for *Arsenicum album* is similar with the results of Trebbi et al. (2016) in which he observed that ultra high dilutions of arsenic were effective in all the experiments, inhibiting spore germination by 60.0 per cent, controlling fungal disease(Dark leaf spot of cauliflower caused by *Alternaria brassicola*) in *in planta* experiments (relative efficacy of 42.1%), and, in field trial, decreasing the mean infection level in cauliflower heads by 45.7 and 41.6 per cent in artificially inoculated and naturally infected plants, respectively. Betti et al (2008) concluded that on the control of dark leaf spot caused by *Alternaria brassicicola* in cauliflower made by As2O3 DH 35 reduced significantly the infection on cauliflower heads compared to control.

Sulphur found effective to control disease next to the *Arsenicum album*. Toledo et al. (2009) evaluated the effect of Sulphur in the control of the early blight on tomato plants. The results showed that Sulphur in 12 and 30CH minimized the severity of disease in ten days after the inoculation with the fungus *Alternaria solani*, and 14 days after inoculation for 6 and 30CH. Toledo *et al.* (2010) reported that there was no direct effect of the biotherapic on the fungus, but there was an effect on the severity of the disease. Toledo *et al*. (2015) evaluated the action of different homeopathic drugs including Sulphur on the control of *Alternaria solani* and on growth variables. According to his findings Sulphur at 12 and 30CH reduced the AUDPC by 17 to 49 per cent. Sulphur at 60CH and hydroalcoholic solution at 10 per cent had a systemic effect on resistance induction. These results prove the finding of this investigation and indicates that homeopathic drugs can control early blight and increase the growth of tomato plants. Patil and Suryawanshi (2014) observed that Sulphur 30 CH was effective showing maximum PCE i.e. 84.45 per cent when used in mixture with mancozeb in strawberry out of total nineteen homeopathic drugs against *Alternaria alternata* which causes fruit rot in strawberry.

Arnica montana was also showed significantly effectiveness against early blight of tomato. Chuarasia and Vyas (1997) observed the remarkable efficacy of homeopathic drugs for checking the leaf rot (lesion) development. *Arnica Montana* was found to be most efficacious amongst all the tested homeopathic drugs.

Sen et al. (2018) observed that ultra high dilution of homeopathic medicines can be used safely for various purposes (Seed germination, betterment of soil health, growth of seedlings, flowering, fruiting, protection against diseases and to overcome environmental stresses). But precautionary measures (proper selection of homeopathic drugs and its potency, proper dilution of drug with water) must be taken before use of these drugs.

Boff *et al.* (2008) conducted two field experiments to study the efficacy of homeopathic preparations for managing pests and diseases in organic farming systems of tomato crops. In the second experiment, potatoes were sprayed with different treatments (homeopathic potencies or propalis extract) and evaluated for yield and intensity of pests and diseases (including *Alternaria solani)* with respect to controls. The homeopathic treatment were found to be good, in an organic farming system, as the standard Bordeaux mixture, and without any residual effect.

Findings of this investigation on efficacy of homeopathic drugs against early blight of tomato at different concentrations and results of different studies by different scientists indicates that homeopathic treatments are significantly effective against early blight of tomato.

4.6 The effect of homeopathic drugs on plant growth in tomato plant under field condition at 10 per cent concentration

Effect of homeopathic drugs on plant growth was measured in tomato plants which were already treated with homeopathic drugs by spraying for disease control. Data for plant growth is presented in Table 11. Plants growth was measured by using three parameters i.e. plant height, No. of branches and No. of leaves on plant.

In this growth measurement, it was observed that most of homeopathic drugs successfully increased the growth of plant over conrol at 10 per cent concentration Recommanded technique that was used in this present studies i.e. tebuconazole at 1ml/L concentration also increased the growth of plant over control.

At 10 per cent concentration, in Sulphur treated plants mean height was 62.13 cm which was at par with *Natrum muriaticum* (60.07cm) followed by Hepar sulphur (59.03cm) which was at par with *Arsenicum album* (58.03cm) followed by *Podophyllum pellatum* (56.57cm) which was at par with tebuconazole (55.83cm) and *Rhus texicodendron* (55.60cm), followed by *Aconitum napellum* (55.1cm) which was at par with *Arnica Montana* (54.67cm) and also on control (54.30cm).

Table 11 Effect of homeopathic drugs (10% Concentration) on plant growth parameters of tomato plant *var Phule kesari*

Sr. No.	Treatment No.	Plant height (cm)*	Number of Branches*	Number of leaves*
1	*Rhux texicodendron*	55.60	8.00	66.00
2	*Podophyllum pellatum*	56.57	11.00	68.00
3	*Natrum muriatum*	60.07	10.00	75.00
4	*Aconitum napellum*	55.10	10.00	65.00
5	*Hepar sulphur*	59.03	11.00	72.00
6	*Arnica Montana*	54.67	8.00	60.00
7	*Sulphur*	62.13	13.00	81.00
8	*Arsenicum album*	58.03	11.00	72.00
9	Tebuconazole 25% EC (1ml/L)	55.83	11.00	64.00
10	Control	54.30	6.00	58.00
	SE (m)+	**0.40**	**0.59**	**0.92**
	CD @ 0.05	**1.19**	**1.76**	**2.76**
	CV	**1.20**	**10.27**	**2.34**

***:-** Mean of three replications

Maximum no. of branches were observed in sulphur (13) followed by *Podophyllum pellatum,* Hepar sulphur, *Arsenicum album* and tebuconazole in which 11 branches were observed followed by *Natrum muriaticum* and *Aconitum napellum* i.e. 10 branches. In homeopathic drugs, minimum mean no. of branches were observed in *Arnica Montana* i.e. 8 branches whereas, in control mean no. branches were 6.

Maximum mean no. of leaves were observed in Sulphur (81) followed by *Natrum muriaticum* (75), Hepar sulphur and *Arsenicum album* (72), *Podophyllum pellatum*(68) which was at par with *Rhus texicodendron* (66), followed by *Aconitum napellum* (65), *Arnica montana* (60), tebuconazole (64) in which minimum no. of leaves were observed. In control mean no. of leaves were 58.

Alternaria solani infected plants are short. Because this fungus inhibits the plant growth. Bos (1978) showed retarted growth in *Alternaria solani* infected plants. Plant height and the number of leaflets/ plant were significantly decreased due to *Alternaria solani* infection.

From the results obtained in this study it was observed that homeopathic drugs increased the growth of plant over control significantly.

Among all homeopathic drugs used in studies as a treatment, at 10 per cent concentration maximum growth in tomato plants infected with A. solani was observed in case

of Sulphur. This finding is similar to the result of Rivas et. al. (1996) in which Seedling growth was stimulated by sulphur 201, 203c. Toledo *et al*. (2015) evaluated that *Sulphur* at 60CH increased the growth of tomato plants infected with *Alternaria solani* over control. Bonato et al (2009) also analyzed the effects of homeopathic drugs *Sulphur* and *Arsenicum album* in growth variables and essential oil content of mint. Among the tested homeopathy drugs, *Sulphur* increased values of fresh and dry biomass more than *Arsenicum album*. Plant height increased by the two drugs and their respective dinamizations. Arsenicum album presented the same behavior as Sulphur drug, with the difference that it increased the fresh biomass in 24 and 30CH dinamizations.

Followed by sulphur, *Natrum muriaticum* showed the increase in plants growth over contol. This result is in consistent with observations of Fonseca et al. (2006). He observed significant effect on tannin content in leaves and roots of medicinal plant *Porophyllum ruderale* and increased the palatability of leaves with only one application of *Sulphur*, *Natrum muriaticum*, Also, Lensi et al (2010) observed that *Natrium muriaticum* had a significative effect of increasing the vegetable growth, mainly in the 6CH dilution when he was studied the action of *Natrium muriaticum* in dilutions 6 CH and 30 CH, in comparison with NaCl solution of 5 per cent, was also studied on *Phaseolus vulgaris.*

Arsenicum album also showed significant findings in case of growth parameters. This result is in agreement with the result of Jager et al., (2011) who observed that *Arsenicum album* in various dilutions Water; succussed water Exposure to As2O3 48 h (intoxication), then plants were transferred to other containers with the treatments *Arsenicum album* increased the growth rate (Number and foliar area, leave color) in *Lemna gibba.*

Tebuconazole increased the plant in some extent over control. This is in agreement with the findings of Tuna (2014) who investigated the effects of five different triazole compounds, triadimenol, tebuconazole, bitertanol, triadimefon, and paclobutrazol on the growth, macro-nutrition, antioxidative enzyme activities and other stress related parameters in *Solanum lycopersicum* L. (tomato) plants grown in greenhouse conditions under salt stress. Triazole compounds treatment significantly enhanced the fresh and dry weight of shoots and roots as well as macro element contents of plant organs. Among the treatments, TRI, TEB, and TDM improved these parameters to a greater extent compared to other compounds.

Sen et al. (2018) observed that ultra high dilution of homeopathic medicines can be used safely for various purposes (Seed germination, betterment of soil health, growth of seedlings, flowering, fruiting, protection against diseases and to overcome environmental stresses). But precautionary measures (proper selection of homeopathic drugs and its potency, proper dilution of drug with water) must be taken before use of these drugs.

4.7 Effect of homeopathic drugs on yield of tomato at 10 per cent concentration

Data of observations for effect of homeopathic drugs on yield of tomato at 10 per cent concentration is presented in Table. 12.

Data revealed that all treatments increased the yield over control. Increase in yield over control ranges from 9.86 to 44.91 per cent. It was observed that tebuconazole was most effective to increase tomato yield i.e. 44.91 per cent whereas minimum increase in yield over control was observed in *Podophyllum pellatum* i.e. 9.86 per cent. Yield from tebuconazole was 32.04 t/ha which was at par with *Arsenicum album* (29.77 t/ha) followed by Suphur (28.86 t/ha) which was at par with *Natrum muriatum* (26.56 t/ha) followed by *Arnica montana* (25.50 t/ha) which was at par with Hepar sulphur (24.72 t/ha), *Aconitum nepallum* (24.74 t/ha), *Rhus texicodendron* (24.52 t/ha), and *Podophyllum pellatum* (24.29 t/ha). From control 22.11 t/ha yield was obtained.

Above results revealed that from the tebuconazole treated plant highest yield was obtained. Finding of Ilhe et. al. (2008) is in support with this result. He investigated that the Tebuconazole 25 EC @ 0.05% (2 sprays) at 15 days interval starting from the appearance of the disease was found to be most effective in controlling the disease early blight (*Alternaria solani*) and powdery mildew (*Leveillula taurica*) of tomato with better yield. Kuryata et. al. (2017) evaluated that the use of tebuconazole retardant during budding leads to increased plant productivity due to optimization of the structure and operation of the plants‟ leaf apparatus. It was established that antigibberelic tebuconazole drug stimulated the formation and functioning of the photosynthetic apparatus of peppers and tomatoes. the actions of tebuconazole led to a significant increase in donor leaves function of peppers and tomatoes, which is an indicator of the growth of net productivity of photosynthesis – the highest among all the variants of the experiment. The results also show that increasing the chlorophyll phytocenotic index was more significant than the increase of leaf index: the tomatoes under the action of tebuconazole had a lower leaf index than in control options, but due to a higher chlorophyll index the crop productivity increased.Since during the fruiting period the costs of assimilates to the growth of vegetative organs are greatly.

It was observed that in most of homeopathic treatments, yield was increased over control significantly. Gangar (2007) proved that medicated water containing drugs of highest potency strongly influences the genetic processes of plants. It can accelerate germination process, can shorten cultivation period, can enhance yield as well as quality of cotton crop and also makes it possible to grow it during off-season.

Sulphur increased the yield of plants over control very effectively. There are various findings of different scientist that are in agreement with this result. Andrade et al., (2001) investigated the effect of homeopathic drugs on J. pectoralis growth, coumarin production and

Table 12. Effect of homeopathic drugs (10 % Concentration) on yield of tomato *var Phule kesari*

Sr. No.	Treatment no.	Yield (t/ha)*	Increased over control(%)
1	*Rhux texicodendron*	24.52	10.90
2	*Podophyllum pellatum*	24.29	9.86
3	*Natrum muriatum*	26.56	20.13
4	*Aconitum napellum*	24.74	11.90
5	*Hepar sulphur*	24.72	11.80
6	*Arnica Montana*	25.50	15.33
7	*Sulphur*	28.86	30.53
8	*Arsenicum album*	29.77	34.64
9	Tebuconazole 25% EC (1ml/L)	32.04	44.91
10	Control	22.11	-
	SE (m)+	0.89	-
	CD @ 0.05	2.65	-
	CV	5.83	-

*:- mean of three replications

electromagnetic field. Weekly spraying (9) of 2.65 ml/plant of solution (10 drops/l water) on J. pectoralis of Sulphur, Arnica montana, 70 per cent increased coumarin yield. But in case of *Arnica Montana*, it didn‟t increase the yield significantly over control. So to this result, result given by Andrade et al., (2001) and Molodon et al. (2012) is controversial in which he observed that the preparation *Arnica montana* 12DH increased the tomato yield under field conditions.

The results of Bonato and Silva (2003) suggested that the homeopathy *Sulphur* can be an alternative to improve the productivity and appearance of commercial agricultural products, with substantial reduction in agricultural input. Chapman and Chapman (2004) investigated the effect of homeopathic medicines on plant growth, Plant size and weight in lettuce. Sulphur, homeopathic drug, potentized water Treatments applied with plants on soil. He observed that Sulphur 1LM influenced plant development.

Sen et al. (2018) observed that ultra high dilution of homeopathic medicines can be used safely for various purposes (Seed germination, betterment of soil health, growth of seedlings, flowering, fruiting, protection against diseases and to overcome environmental stresses). But precautionary measures (proper selection of homeopathic drugs and its potency, proper dilution of drug with water) must be taken before use of these drugs.

5. SUMMARY AND CONCLUSION

The present studies on “Field testing of homeopathic drugs against early blight (A*lternaria solani*) [Ell. and Martin] Jones and Grout of tomato” was undertaken with a view of investigation on economically and environmentally sound method to control early blight disease tomato caused by *Alternaria solani* which is frequently occurring and economically important disease in maharashtra. Studies under field condition were carried on tomato variety *Phule kesari* during kharif season of 2019. The results obtained during this investigation are summarized as below.

Effects of different homeopathic drugs of 30CH dilutions were evaluated on mycelial growth of pathogenic fungus, germination of tomato seeds, plant disease incidence and intensity under field condition, growth of tomato plants and yield of tomato. Effect of total forteen homeopathic drugs were evaluated in laboratory. Treatments that found effective under *in vitro* evaluation used for further evaluation in field condition. Eight different types of homeopathic drugs that found effective in laboratory were evaluated for their efficacy to control early blight of tomato caused by *Alternaria solani*. Results obtained from homeopathic drugs treatments were compared with results given by tebuconazole 25% EC over control which was used as a chemical check under *in vitro* studies and as a recommended technique in field condition.

Pathogen was isolated from diseased samples that showing typical symptoms of early blight of tomato. Pothogenecity of isolated pathogen was proved in controlled green house condition by using Koch‟s postulate and identification of pathogen was confirmed as an early blight tomato causing fungus i.e. *Alternaria solani* by observing typical symptoms of early blight of tomato on test plant and morphology of fungus under microscope.

In vitro evaluation of homeopathic drugs against mycelial growth of fungal pathogen showed that 10 per cent concentration of homeopathic drugs was most effective to inhibit mycelial growth of fungus than 5 per cent concentration Inspite of this, *Arnica Montana* and *Arsenicum album* showed 60 and 58.8 per cent mycelial growth inhibition at 5 per cent. Whereas, at 10 per cent concentration *Arsenicum album* inhibited 97.7 per cent mycelial growth which was as effective as tebuconazole (1ml/L concentration) which inhibited 100 per cent mycelial growth. At this concentration sulphur was also effective next to the *Arsenicum album* which inhibited mycellial growth by 88.8 per cent over control followed by *Natrum muriaticum* (81.10%) and *Arnica montana* (78.8%).

Natrum muriaticum was found most effective in germination test followed by *Arnica montana*, *sulphur*, *Arsenicum album* and *Hepar sulphur* that increased germination at 0.1 per cent concentration over control significantly whereas increased in conc at 0.5 per cent

decreased the germination in tomato seeds. Seeds that treated with homeopathic drugs at 0.1 per cent concentration were used for growing of seedlings of tomatoes on field.

In field condition, two concentrations of homeopathic drugs were evaluated for early blight plant disease incidence and intensity on tomato plants i.e. 5 and 10 per cent. At 5 per cent concentration, all treatments showed nearly same effect on the disease incidence and disease intensity over control initially. Disease incidence and incidence gradually reduced at. 10% concentration of homeopathic drugs as no. of spraying increased but among all homeopathic drugs *Arsenicum album* and *sulphur* found most effective against early blight disease (*Alternaria solani*) as compared to 5 per cent concentration Whereas, it was found that homeopathic drugs more effectively reduced the severity/ intensity of disease than disease incidence.

At 5 per cent concentration of homeopathic drugs, after first spraying, maximum reduction in disease incidence over control was observed in *Arsenicum album* i.e. 10.23 per cent. which was at par with all other treatments except *Rhus texicodendron* which had no effect on disease was found. In case of disease intensity one treatment reduced the severity of disease over control. Whereas, among all treatments recommended technique i.e. tebuconazole at 1ml/L concentration showed maximimum efficacy against disease incidence and disease intensity i.e. 39.46 per cent reduction in disease incidence over control and 43.98 per cent reduction in disease intensity over control. After second spraying, in all treatments disease incidence and disease intensity was increased but the rate of plant disease incidence and intensity was comparatively low in treated plots than control. Percent reduction in disease incidence and intensity over control was increased in some extent after second spray at 5 per cent concentration in *Arsenicum album, sulphur, Natrum muriaticum, Arnica montana, Hepar sulphur and Aconitum napellum.* At 1ml/L conc tebuconazole was most effective in all treatments in which 55.09 per cent reduction in disease incidence and 61.13 per cent reduction in disease intensity was observed, after second spray. Among homeopathic drugs, maximum percent reduction in plant disease incidence and intensity over control was observed in *Arsenicum album, Sulphur, Natrum muriaticum* and *Arnica montana*, showed equal effectiveness of these treatments against plant disease incidence and intensity at 5 per cent concentration but it was much less effectiveness than at 10 per cent concentration Again after third spraying of homeopathic drugs at 5 per cent concentration disease incidence and disease intensity was increased in plants but the rate of increasing was lower than second spraying over control and percent reduction in disease incidence and disease intensity over was also increased than second spraying. After third spraying maximum reduction in disease incidence and intensity over control was observed in tebuconazole (1ml/L) i.e. 70 per cent and 75.76 per cent respectively. Among homeopathic drugs, maximum reduction in disease incidence and intensity was observed in *Arsenicum album* and sulphur followed by *Natrum*

muriaticum and *Arnica montana*. Next to these, other remaining treatment showed reduction in plant disease incidence and intensity in some extent over control.

At 10 per cent concentration efficacy of homeopathic drugs against early blight of tomato was increased than at 5 per cent concentration As frequency of periodical spraying increased, percent reduction in disease over control was also increased. At this concentration, after first spraying, maximum reduction in disease incidence and disease intensity over control was observed in *Arsenicum album* i.e. 29.34 and 34.40 per cent respectively and sulphur i.e. 25.98 and 33.78 per cent respectively. In tebuconazole, 32.88 and 32.49 per cent reduction in disease incidence and intensity respectively was found. In case of disease incidence, among all treatments minimum percent disease incidence over control was observed in tebuconazole (1ml/L) i.e. 19.45 per cent. In case of homeopathic drugs, *Arsenicum album* (22.70%) and sulphur (23.78%) found superior to all other homeopathic drugs treatments against disease incidence. *Natrum muriatum* and *Arnica montana* also significantly reduced the disease incidence over control next to these treatments. In rest of the treatments, percent disease incidence after first spraying at 10 per cent concentration ranged from 26.80 to 30.11 per cent. In case of disease intensity, at this concentration *Arsenicum album* (34.40%) and sulphur (33.78%) found equally effective against disease intensity followed by *Natrum muriaticum* and *Arnica montana* with 22.74 and 21.78 per cent reduction in disease intensity over control, respectively. In rest of the treatments, percent reduction in disease intensity was observed between the range of 2.9 to 16.92 per cent. After second spraying, in all treatments disease incidence and disease intensity was increased but the rate of plant disease incidence and intensity was comparatively lower than after first spray at 10 per cent concentration and than after second spray at 5 per cent concentration in treated plots over control. Percent reduction in disease incidence and intensity over control was also increased after second spray in all treatments. At 1ml/L conc in tebuconazole 55.1 per cent reduction in disease incidence and 61.13 per cent reduction in disease intensity was observed, after second spray. In case of disease incidence, *Arsenicum album* (32.77% reduction in disease incidence) and sulphur (32.05% reduction in disease incidence) were found equally effective against disease incidence followed by *Natrum muriaticum, Arnica montana*. Mimimum reduction in disease incidence at this concentration was observed in *Rhus texicodendron*. In case of disease intensity, again *Arsenicum album* (44.81%), *and sulphur* (41.44%) showed equal effectiveness followed by *Natrum muriaticum* (30.46%) and *Arnica montana* (27.04%) over control. In rest of the treatments percent reduction in disease intensity ranged from 16.55 to 22.54 per cent among which minimum reduction in disease intensity over control was found in *Rhus texicodendron.* After third spraying, *Arsenicum, sulphur, Natrum muriaticum* and *Arnica montana* reduced the plant disease incidence and intensity very effectively over control. Disease incidence and

intensity increased in all treatments (except recommended technique tebuconazole 25% EC) than it was after second spraying but plant disease incidence and intensity rate was much lower than previous and for homeopathic drugs, it was much lower than it was after third spraying at 5 per cent concentration At 1ml/L concentration tebuconazole showed percent reduction in disease incidence and intensity 70 and 75.78 per cent, respectively. In case of disease incidence, *Arsenicum* and *sulphur* found most effective followed by *Natrum muriaticum* and *Arnica montana* at 10 per cent concentration over control in which percent disease incidence ranged from 28.19 to 40.35 per cent in which *Rhus toxicodendron* found less effective. Whereas, in case of disease intensity, maximum reduction in disease intensity over control found in tebuconazole. Among homeopathic drugs treatment *Arsenicum album* and sulphur found equally effective against disease intensity of early blight intensity on tomato plants followed by *Natrum muriaticum* and *Arnica montana.* followed by Hepar sulphur, *Aconitum napellum* and *Podophyllum pellatum* which were found equally effective against disease intensity over control. *Rhus toxicodendron* showed minimum percent reduction in disease intensity over control i.e. only 17.80 per cent.

Effect of different homeopathic drugs at 10 per cent conc and effect of tebuconazole at 1ml/L concentration on growth of tomato plants over control was measured. It was observed that sulphur and *Natrum muriaticum* increased the plant growth at maximum rate over control followed by Hepar sulphur and *Arsenicum album* followed by *Podophyllum pellatum* and tebuconazole.

Any type of management practice become successful only and only if when it could be increase the yield as a final product. In this investigation on early blight of tomato, effect of seed treatment and spraying of different homeopathic drugs for disease management on yield on was measured i.e. in this studies yield was a combine effect of seed treatment and plant treatment (spraying of drugs) in case of homeopathic drugs. It is observed that among homeopathic drugs maximum yield over control was given by plants treated with *Arsenicum album* (29.77 t/ha) which is equally effective with tebuconazole (32.04 t/ha) followed by sulphur (28.86 t/ha) and *Natrum muriaticum* (26.56 t/ha). In case of rest of the treatments obtained yield ranged from 24.29 to 25.50 t/ha. Whereas, from control plants 22.11 t/ha yield was obtained.

Conclusion:

1. Pathogenicity of *Alternaria solani* as a causal agent of early blight of tomato was proved by using Koch‟s postulate.
2. 100 per cent mycelia growth inhibition under *In vitro* evaluation was observed in chemical check i.e. tebuconazole 25% EC.

3. In *In vitro* evaluation of homeopathic drugs treatment @ 5 per cent concentration,the treatment *Arnica montana* and *Arsenicum album* reported the maximum mycelial growth inhibition over control but as concentration increased to 10 per cent, mycelial growth inhibition increased effectively in all homeopathic treatments than @ 5 per cent including *Arnica montana* and *Arsenicum album* in the range of 97.7 to 62.30 percent @ 10 per cent concentration Maximum mycelial growth inhibition observed in *Arsenicum album* (97.7%) followed by Sulphur (88.8%), *Natrum muriaticum* (81.10%) and *Arnica montana* (78.8%).
4. *Natrum muriaticum*, *Arnica montana* and *sulphur* were found most effective in germination test that increased germination most effectively @ 0.1% concentration over control.
5. *Arsenicum album* and *Hepar sulphur* moderately increased the germination of tomato seeds @ 0.1 per cent concentration of homeopathic drugs.
6. As concentration of homeopathic drugs was increased for seed treatment, it decreased the germination of tomato seeds.
7. Under field condition 10 per cent concentration of homeopathic drugs found most effective for management of early blight disease (*Alternaria solani*) of tomato than 5 per cent concentration
8. As frequency of homeopathic drugs spraying was increased, percent reduction in disease incidence and disease intensity (severity) was also increased.
9. Maximum effectiveness against early blight (*Alternaria solani*) of tomato was observed in tebuconazole 25% EC @ 1ml/L concentration which was used as a recommended fungicide in present studies which is followed by 10 per cent concentration homeopathic drugs *Arsenicum album, sulphur, Natrum muriaticum*, *Arnica montana*, Hepar sulphur and *Aconitum nepallum* significantly reduced the disease incidence and disease intensity over control under field condition.
10. The significant minimum disease incidence i.e. 15.17 per cent and intensity 11.45 per cent was reported in the treatment tebuconazole 25% EC @ 1ml/L which was followed by *Arsenicum album* (40.35% disease incidence and 36.68% disease intensity) and sulphur (41.21% disease incidence and 37.72% disease intensity) @ 5 per cent concentration after third spray.
11. Whereas, 10 per cent concentrationof homeopathic drugs, minimum plant disease incidence and intensity after tebuconazole was observed in *Arsenicum album* (30.16% disease incidence and 22.84% disease intensity) and sulphur (31.13% disease incidence and 24.47% disease intensity) after third spray.
12. From this, it was concluded that among all homeopathic drugs, *Arsenicum album* and sulphur was superior over control against early blight of tomato.

13. Followed by *Arsenicum album* and Sulphur, *Natrum muriaticum and Arnica montana* found equally effective against early blight disease at 10 per cent concentration
14. It was observed that in homeopathic drugs were most effective against disease intensity of early blight of tomato than disease incidence.
15. *Rhus texicodendron* showed lowest reduction in plant disease incidence and intensity over control under field condition.
16. It was observed that sulphur and *Natrum muriaticum* increased the plant growth at maximum rate over control @ 10 per cent concentration followed by Hepar sulphur and *Arsenicum album* followed by *Podophyllum pellatum* and tebuconazole 25% EC (1ml/L).
17. Among all homeopathic drugs, maximum yield over control was reported in the treatment of *Arsenicum album* (29.77 t/ha) @ 10 per cent concentration which is at per with tebuconazole 25% EC (32.04 t/ha) followed by sulphur (28.86 t/ha) and *Natrum muriaticum* (26.56 t/ha). In case of rest of the treatments obtained yield ranged from 24.29 to 25.50 t/ha. Whereas, from control plants 22.11 t/ha yield was obtained. It was combined effect of increase in seed germination, plant growth and effectively management of disease that leads to increase in yield over control.
18. From the above results, it was concluded that @ 10 per cent concentration homeopathic drugs that used in this studies were moderately effective for ecofriendly management of early blight of tomato (*Alternaria solani*) as compared to recommended fungicide tebuconazole 25% @ 1ml/L at field condition.

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7. VITAE

Miss. POTE KALYANI ISHWAR

MASTER OF SCIENCE (AGRICULTURE)

IN

PLANT PATHOLOGY

2021

Title of thesis		**:**	"FIELD TESTING OF HOMEOPATHIC DRUGS AGAINST EARLY BLIGHT (*Alternaria solani*) [Ell. And Martin] Jones and Grout OF TOMATO"
Major field		**:**	Plant Pathology
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	Place of Birth	**:**	Virkund, Wani. Dist. Yavatmal.
	Father's Name	**:**	Mr. Pote Ishwar Shrihari
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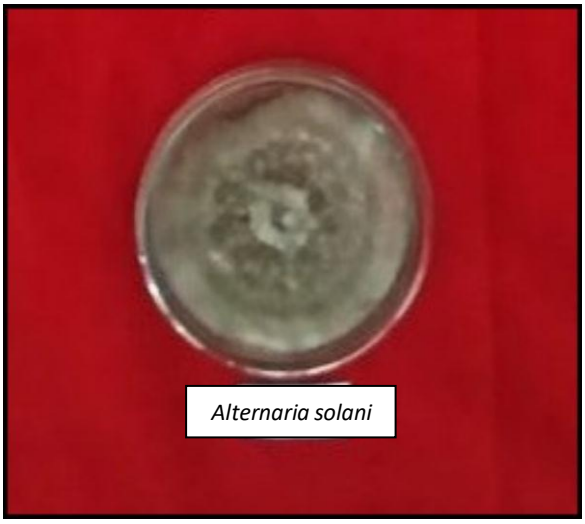
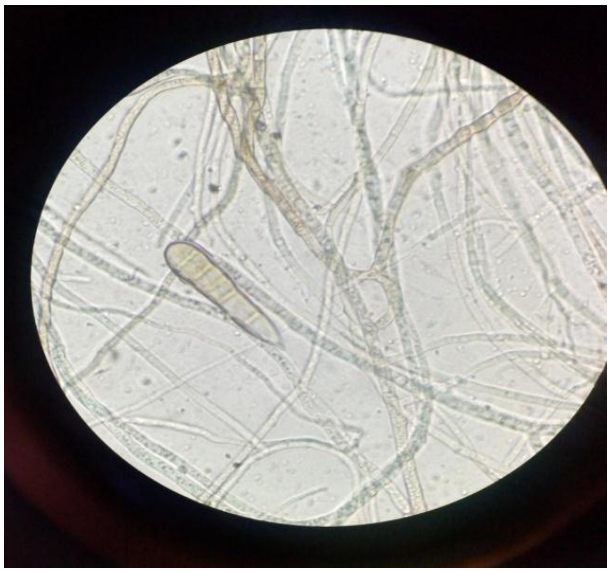
A) **Typical symptom of early blight on tomato leaf**



B) ***Alternaria solani***



C) Conidia of *Alternaria solani*

Plate 1: Typical symptoms of early blight on tomato plant, isolated culture of *Alternaria solani* and microscopic observation of isolated fungus

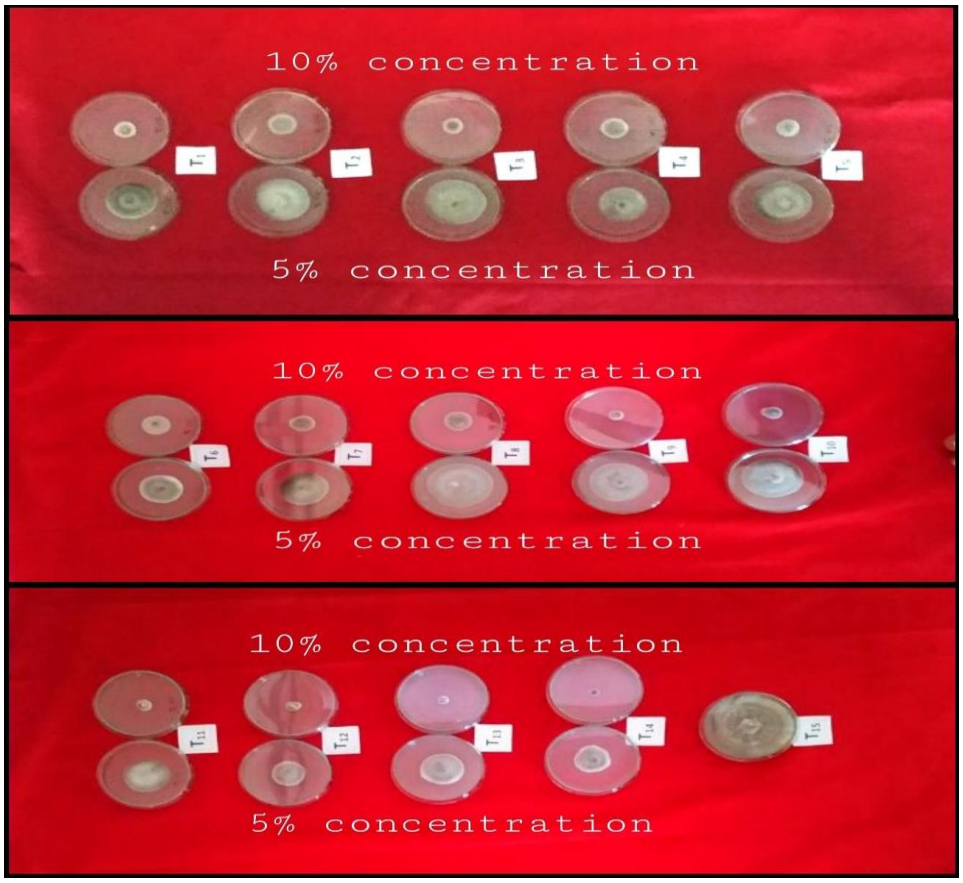


Plate 1: a) Effect of homeopathic drugs on mycelial growth of *Alternaria solani*

Plate 1: b) Effect of recommended fungicide i.e. tebuconazole 25% EC on mycelial growth of *Alternaria solani*

A) Effective Homeopathic drugs for increasing seed germination over control at 0.1% conc.

B) Effect of homeopathic drugs on seed germination of tomato at 0.5% conc.

Plate 3: Effect of homeopathic drugs on tomato seed germination over control at 0.1 and 0.5 per cent concentration

Rhus texicodendron

Podophyllum pellatum

Natrum muriaticum

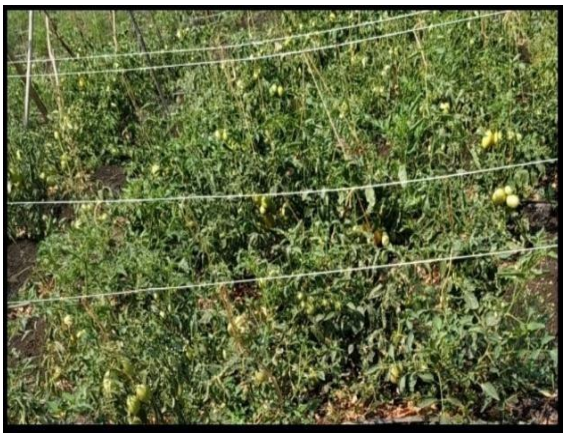
Aconitum napellum

Hepar sulphur

Plate 4 a): Effect of spraying of homeopathic drugs at 5 per cent concentration on tomato plants and disease under field condition

Arnica montana

Sulphur

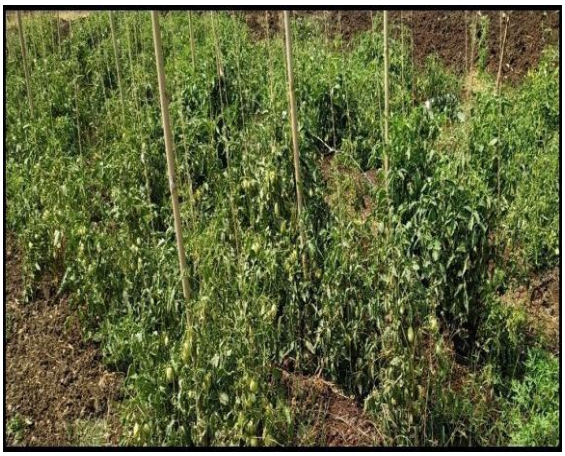


Arsenicum album

Tebuconazole 25% EC

Control

Plate 4 b): **Effect of spraying of homeopathic drugs at 5 per cent concentration on tomato plants and disease under field condition**



Rhus texicodendron

Podophyllum pellatum

Natrum muriaticum

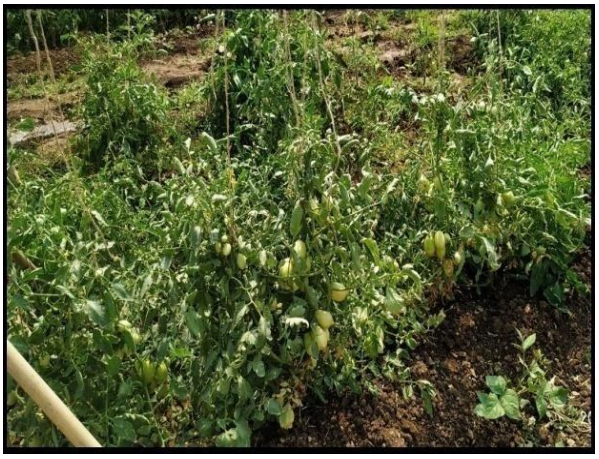
Aconitum napellum

Hepar sulphur

Plate 5 a): Effect of spraying of homeopathic drugs at 10 per cent concentration on tomato plants and disease under field condition

Arnica montana

Sulphur



Arsenicum album

Tebuconazole 25% EC

Control

Plate 5 b): Effect of spraying of homeopathic drugs at 10 per cent concentratyion on tomato plants and disease under field condition

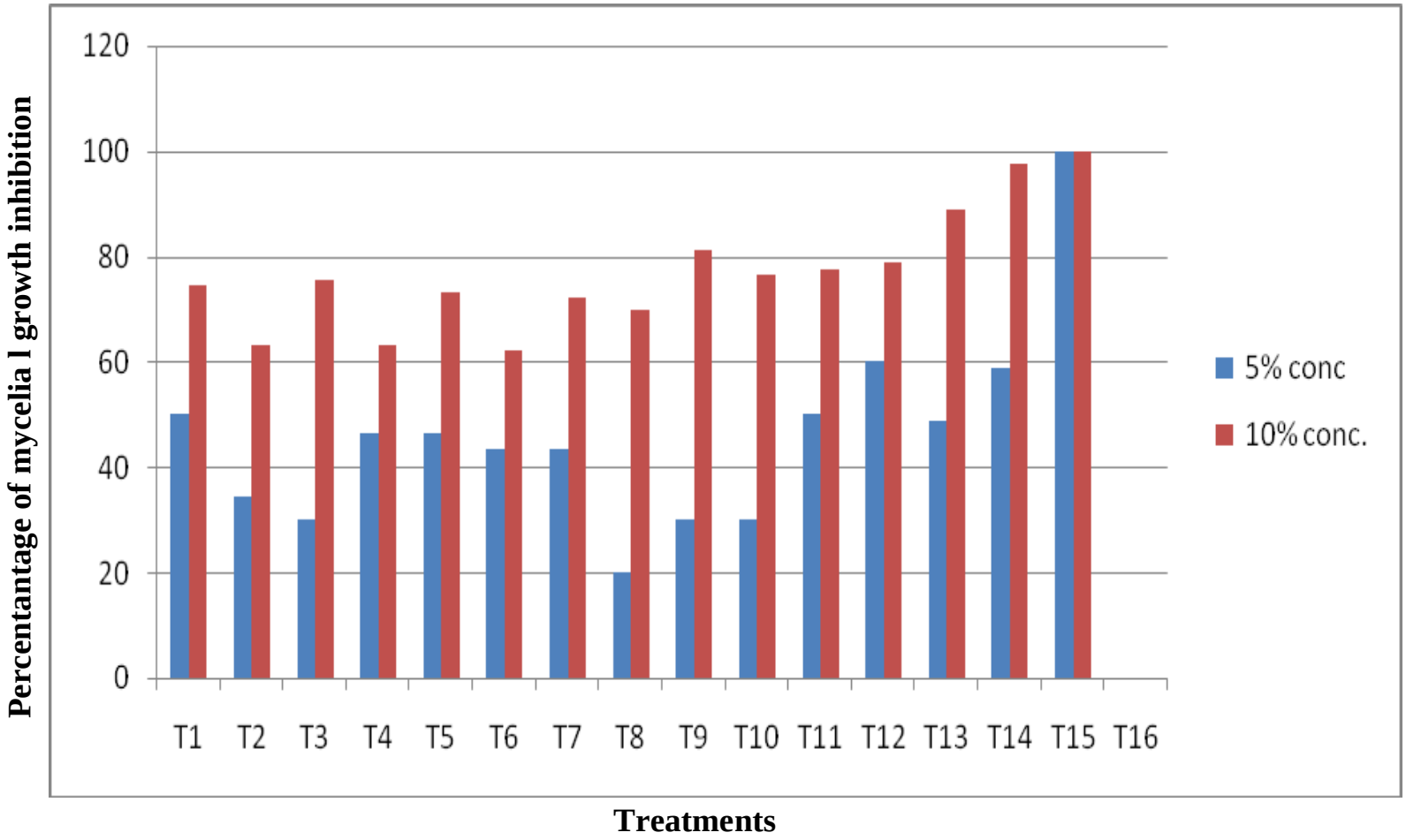


Fig. 1: *In vitro* efficacy of homeopathic drugs against mycelial growth of *Alternaria solani* at 5 and 10 per cent concentration

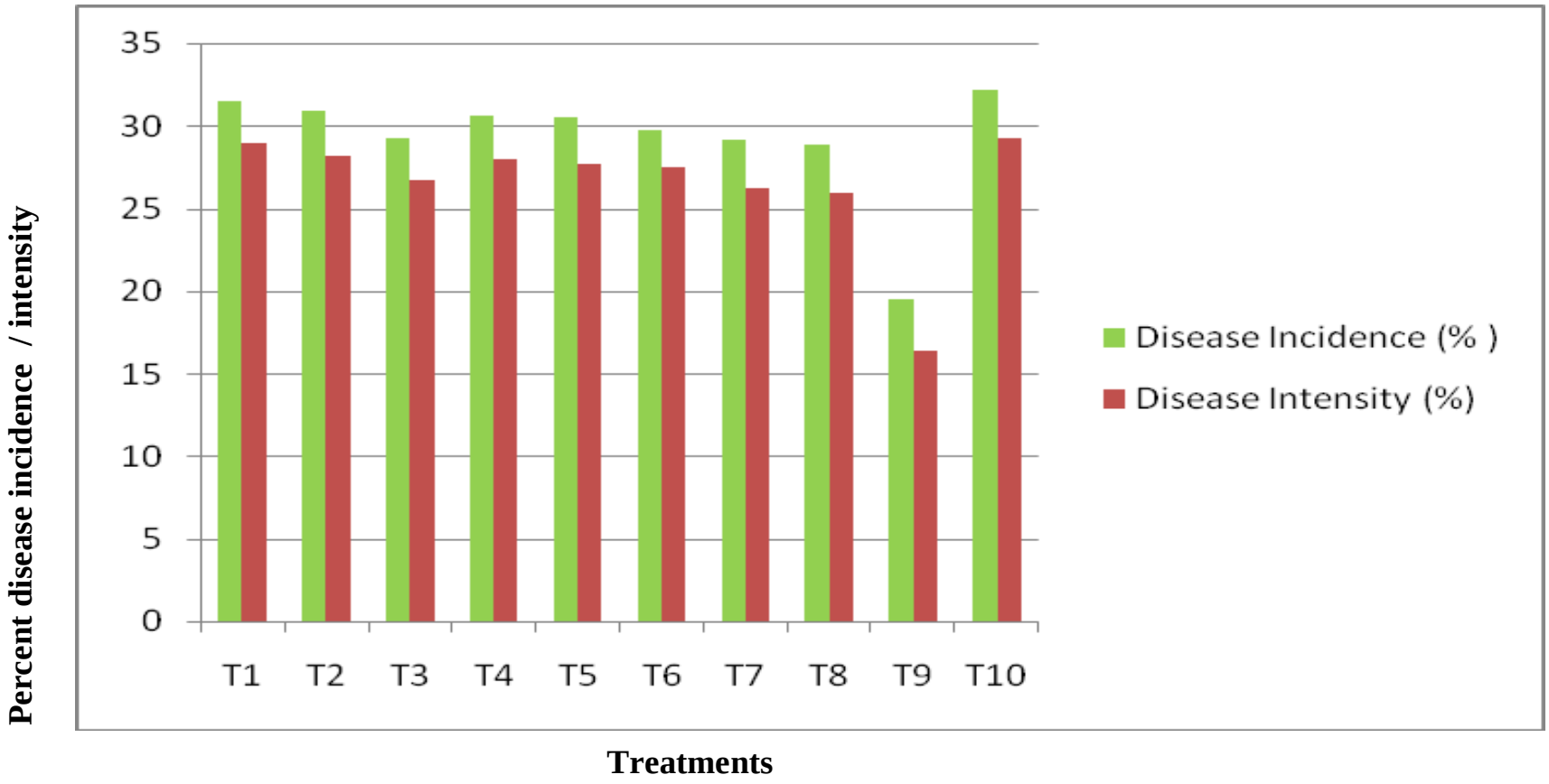


Fig 2: Effect of homeopathic drugs on disease incidence and disease intensity under field condition at 5 per cent concentration after first spray

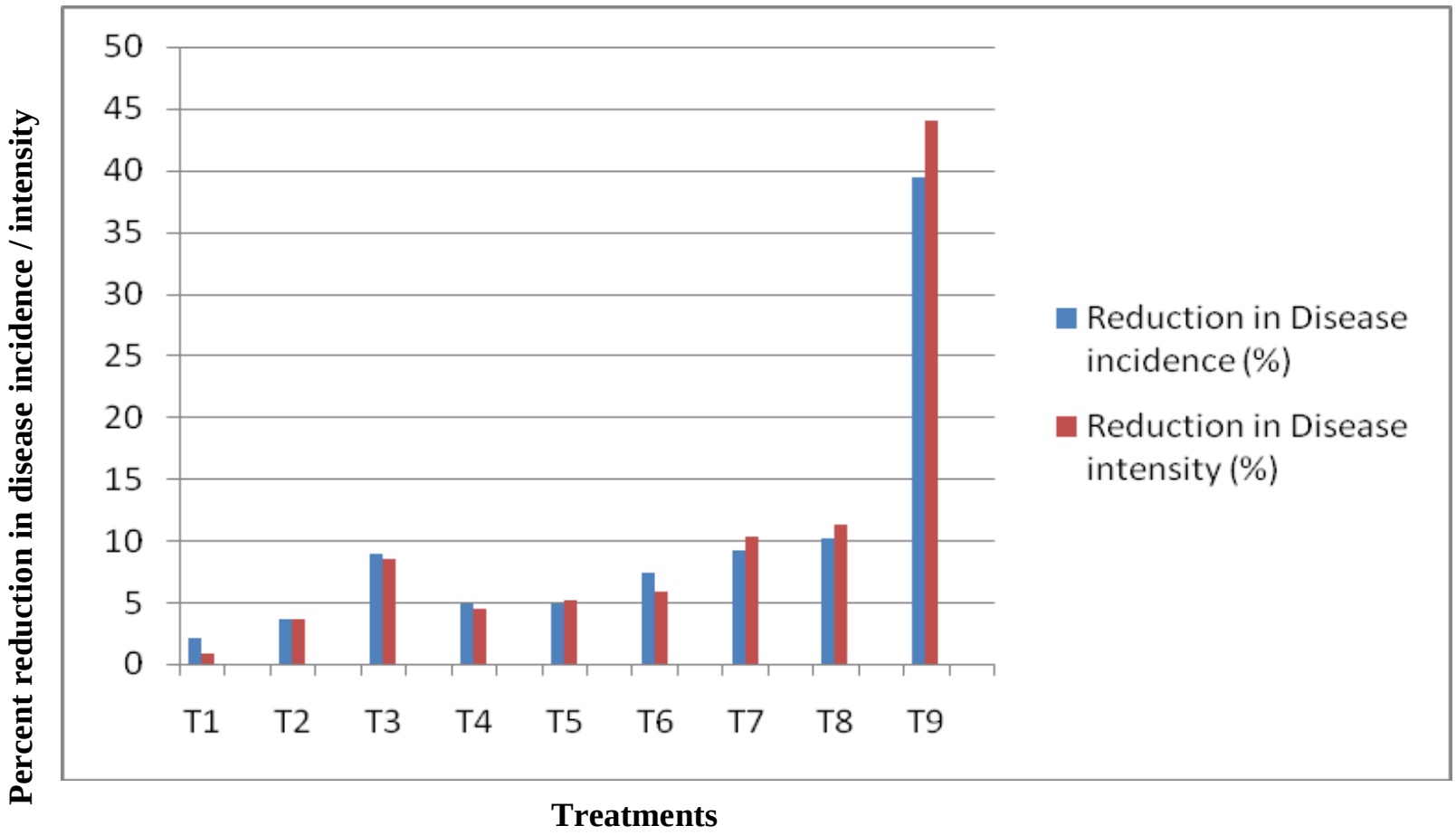


Fig 3: Reduction in disease incidence and disease intensity over control as a effect of homeopathic drugs at 5 per cent concentration after first spraying

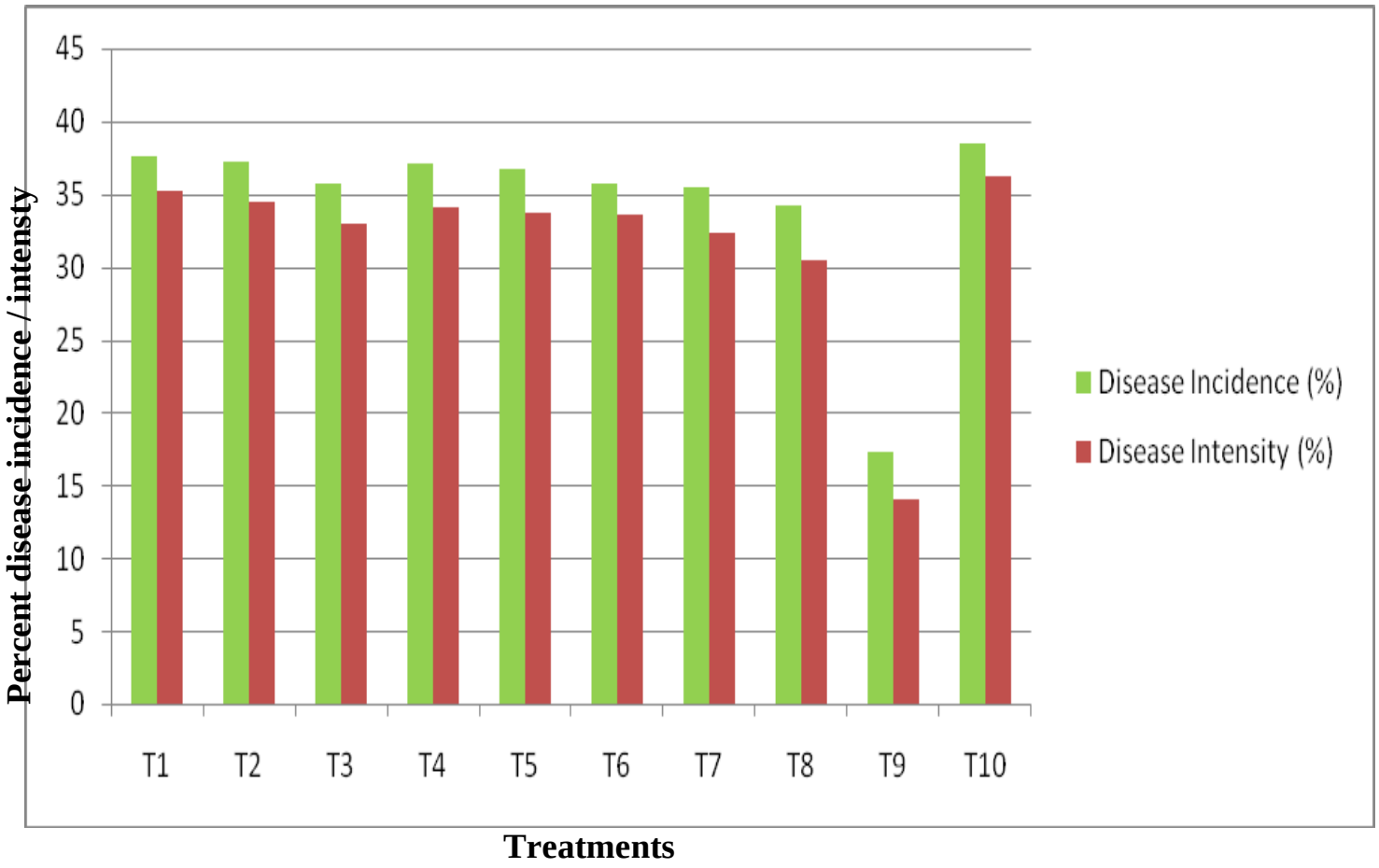


Fig. 4 Effectof homeopathic drugs on disease incidence and disease intensity at 5 per cent concentration after second spraying

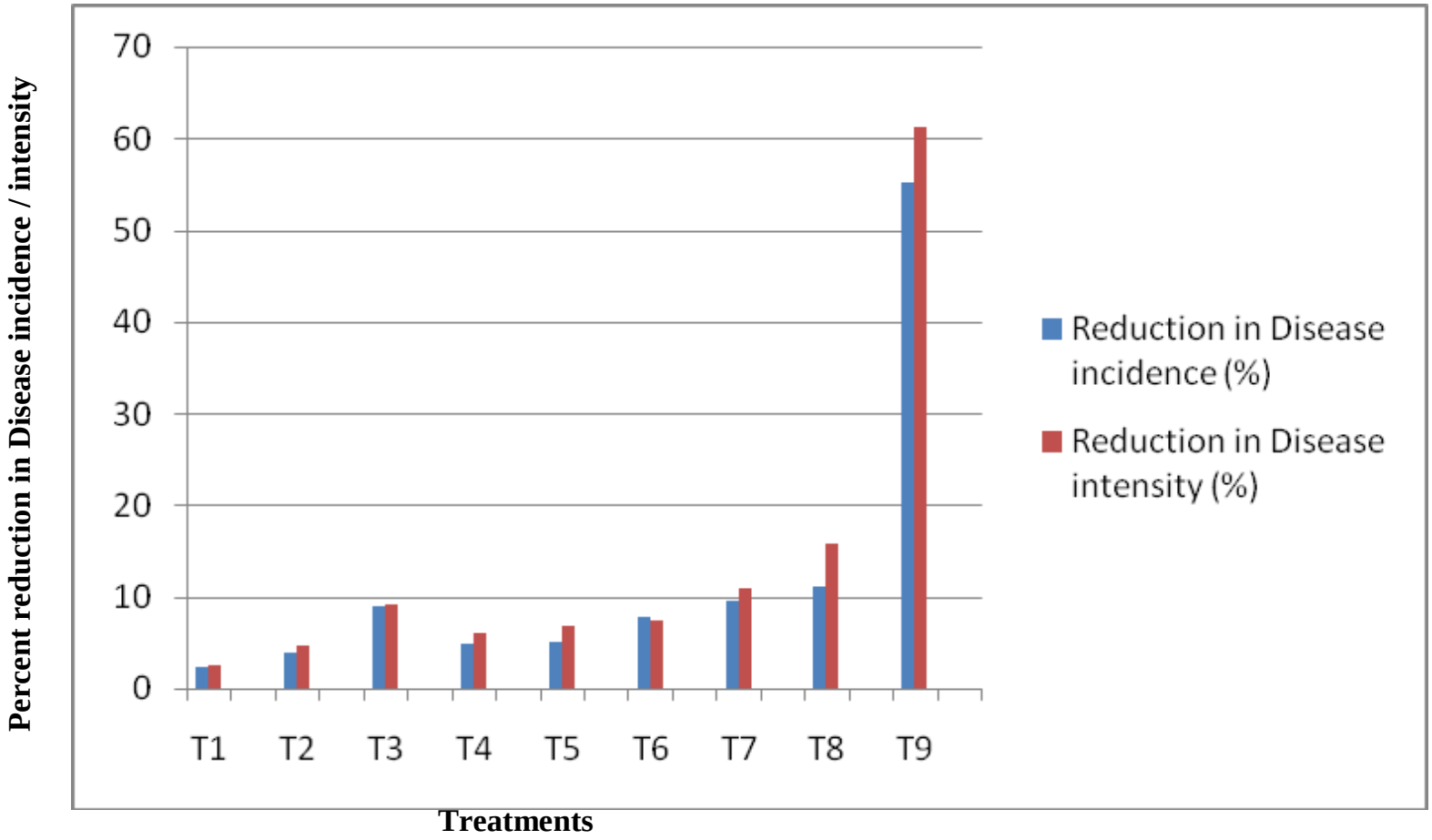


Fig. 5 Reduction in percent disease incidence and disease intensity over control as a effect of homeopathic drugs at 5 per cent concentration after second spray

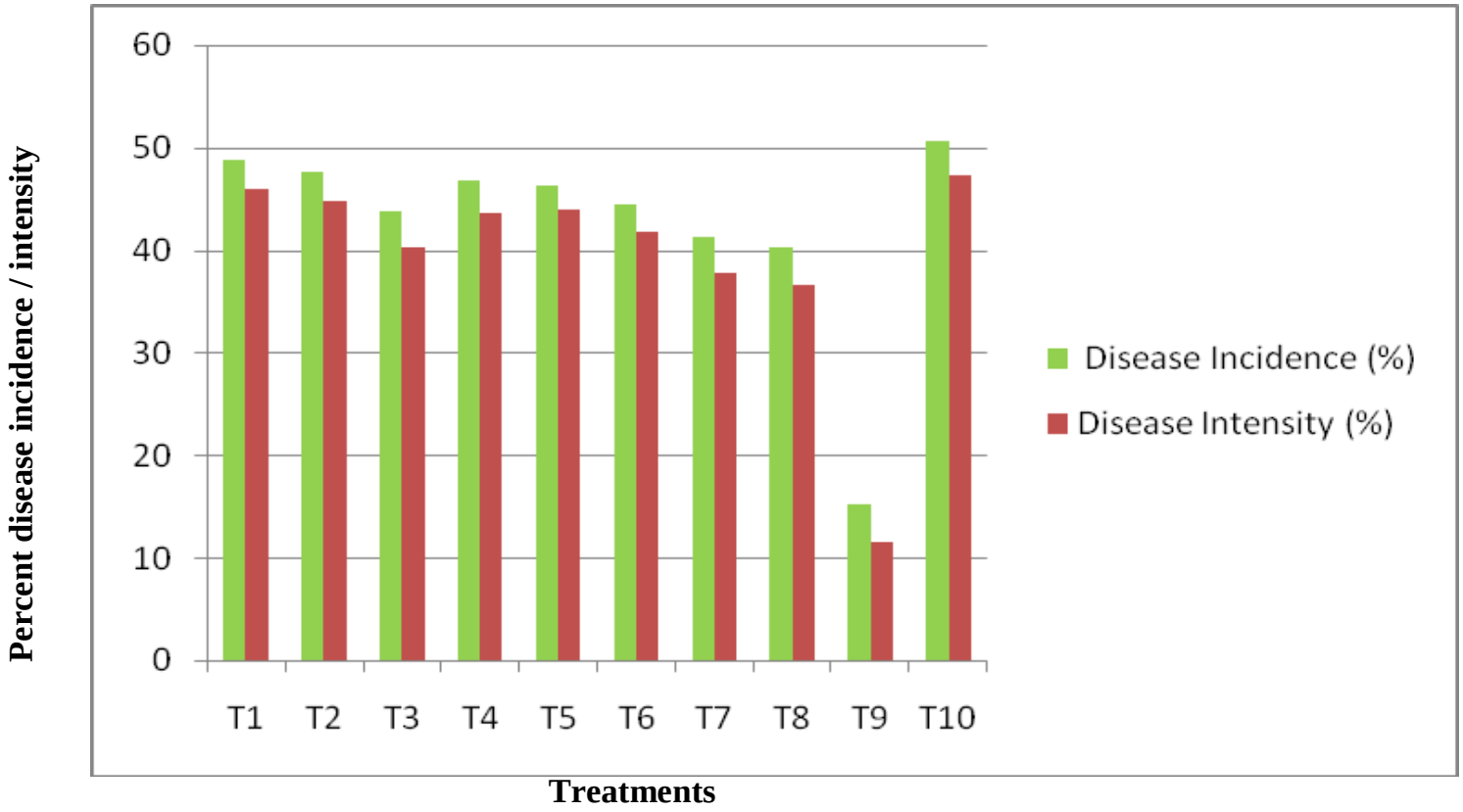


Fig. 6: Effect of homeopathic drugs on disease incidence and disease intensity at 5 per cent concentration after third spray

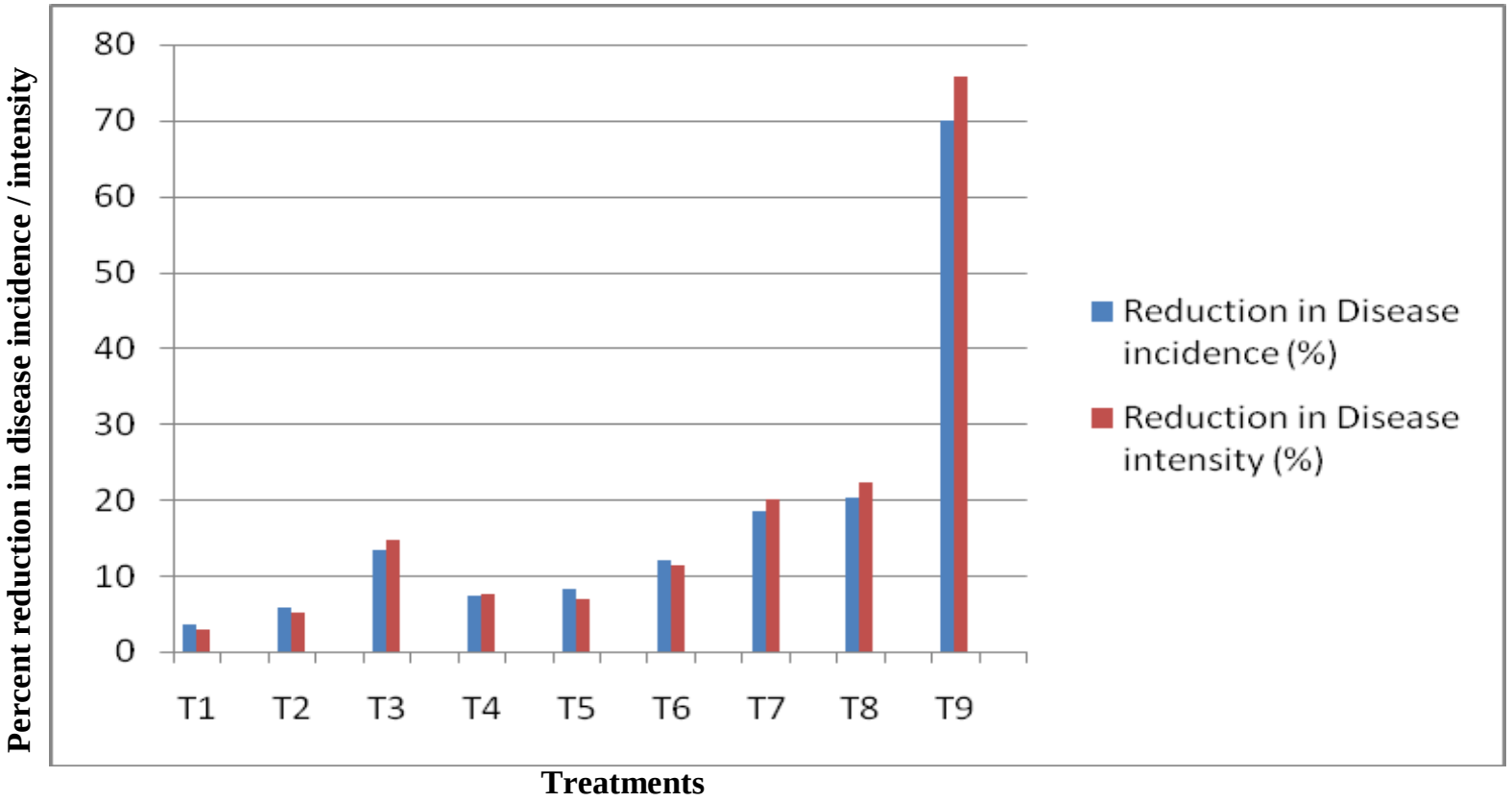


Fig. 7: Reduction in disease incidence and disease intensity over control as a effect of homeopathic drugs at 5 per cent concentration after third spraying

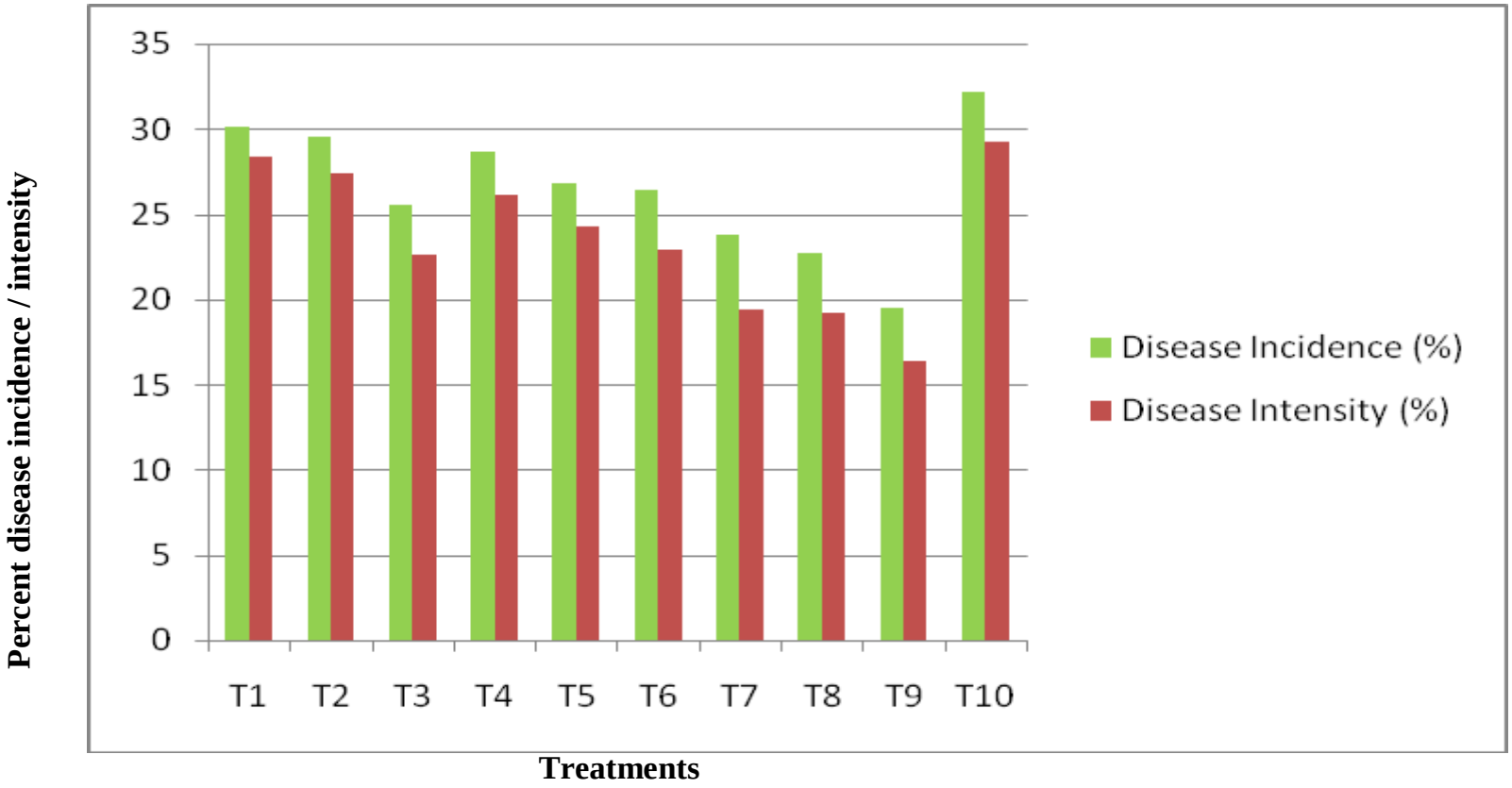


Fig. 8 : Effect of homeopathic drugs on disaese incidence and disease intensity at 10 per cent concentration after first spray

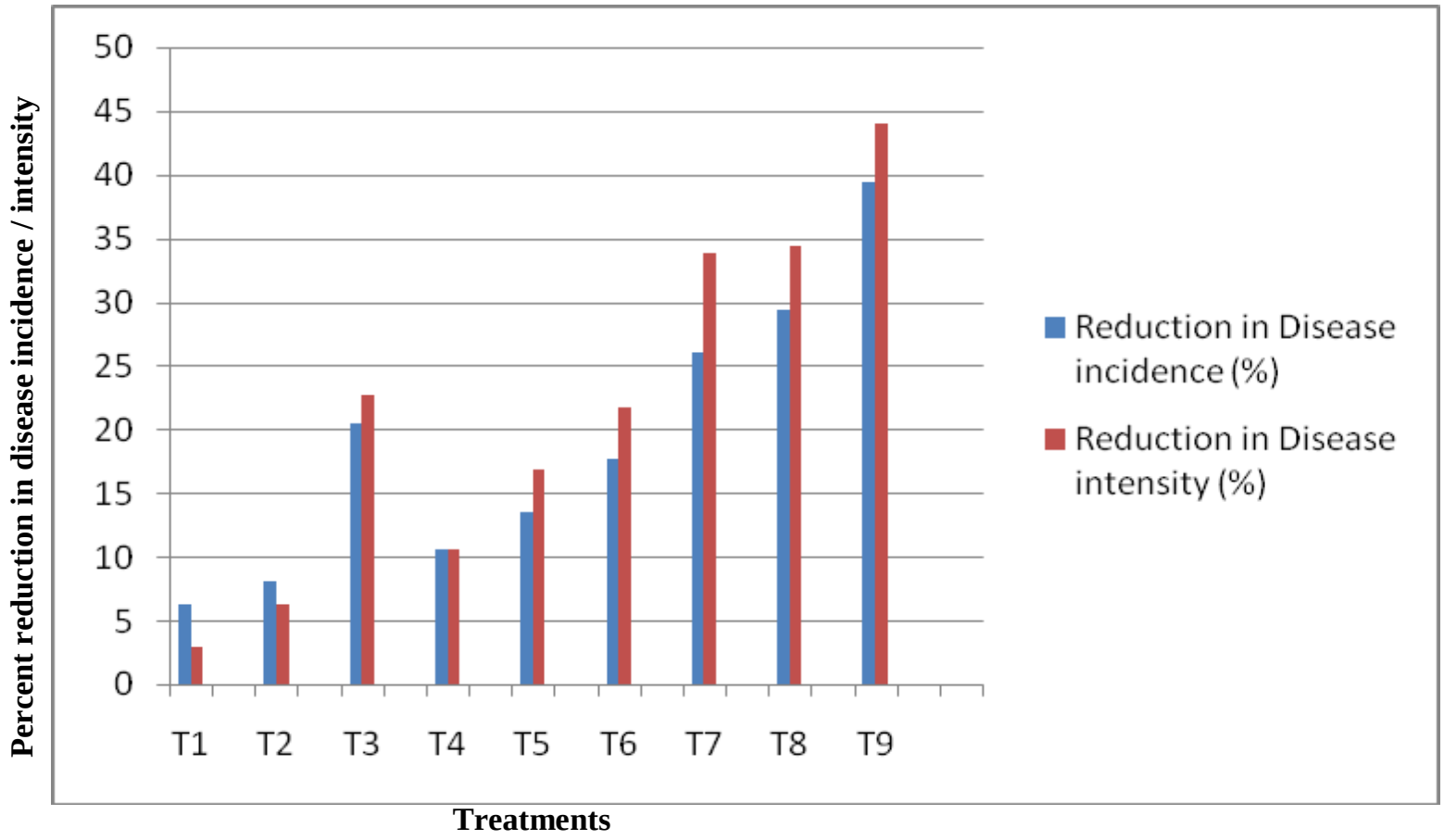


Fig. 9 : Reduction in disease incidence and disease intensity over control as a effect of homeopathic drugs at 10 per cent concentration after first spray

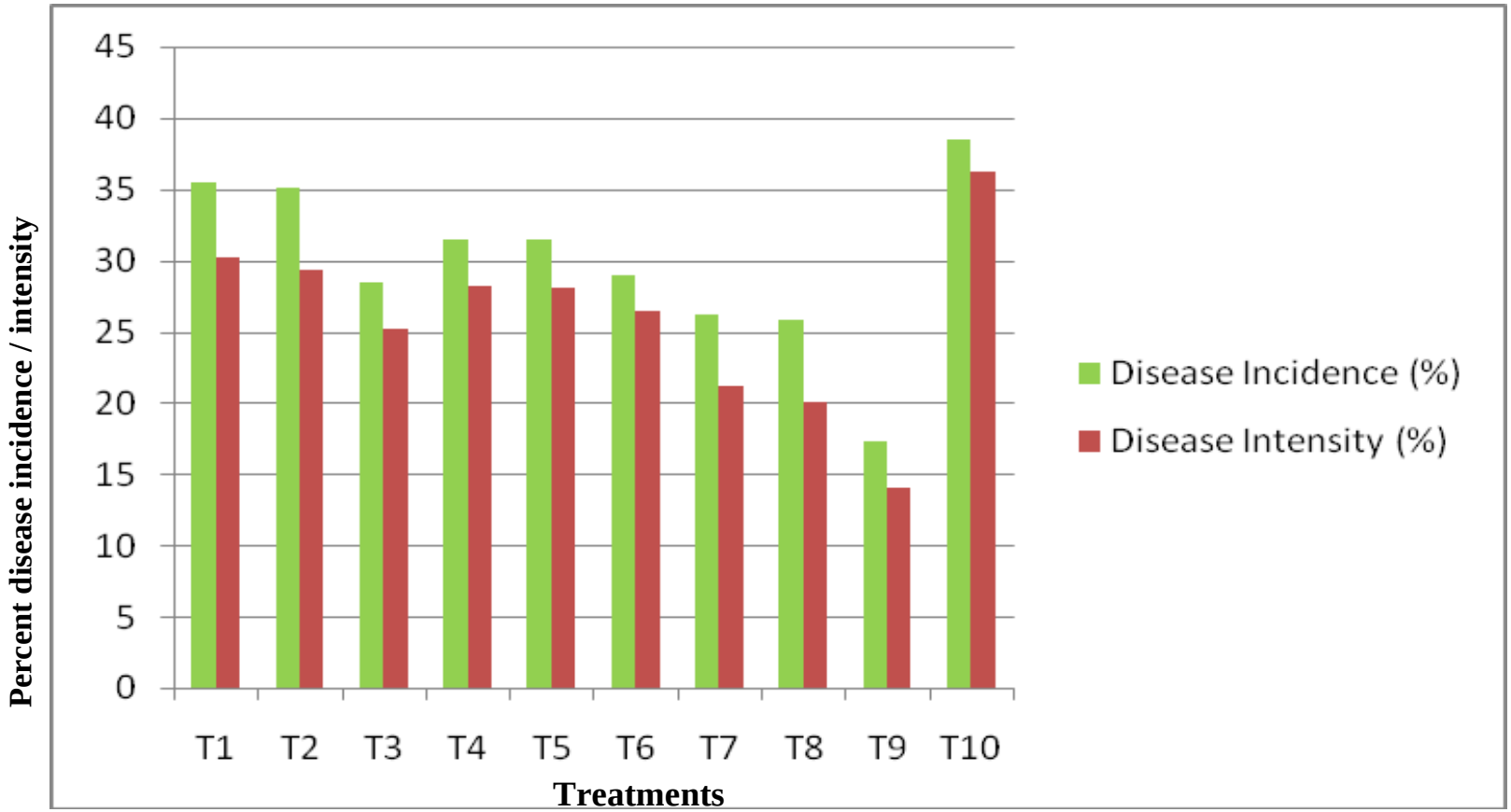


Fig. 10: Effect of homeopathic drugs on disease incidence and disease intensity at 10 per cent concentration after second spray

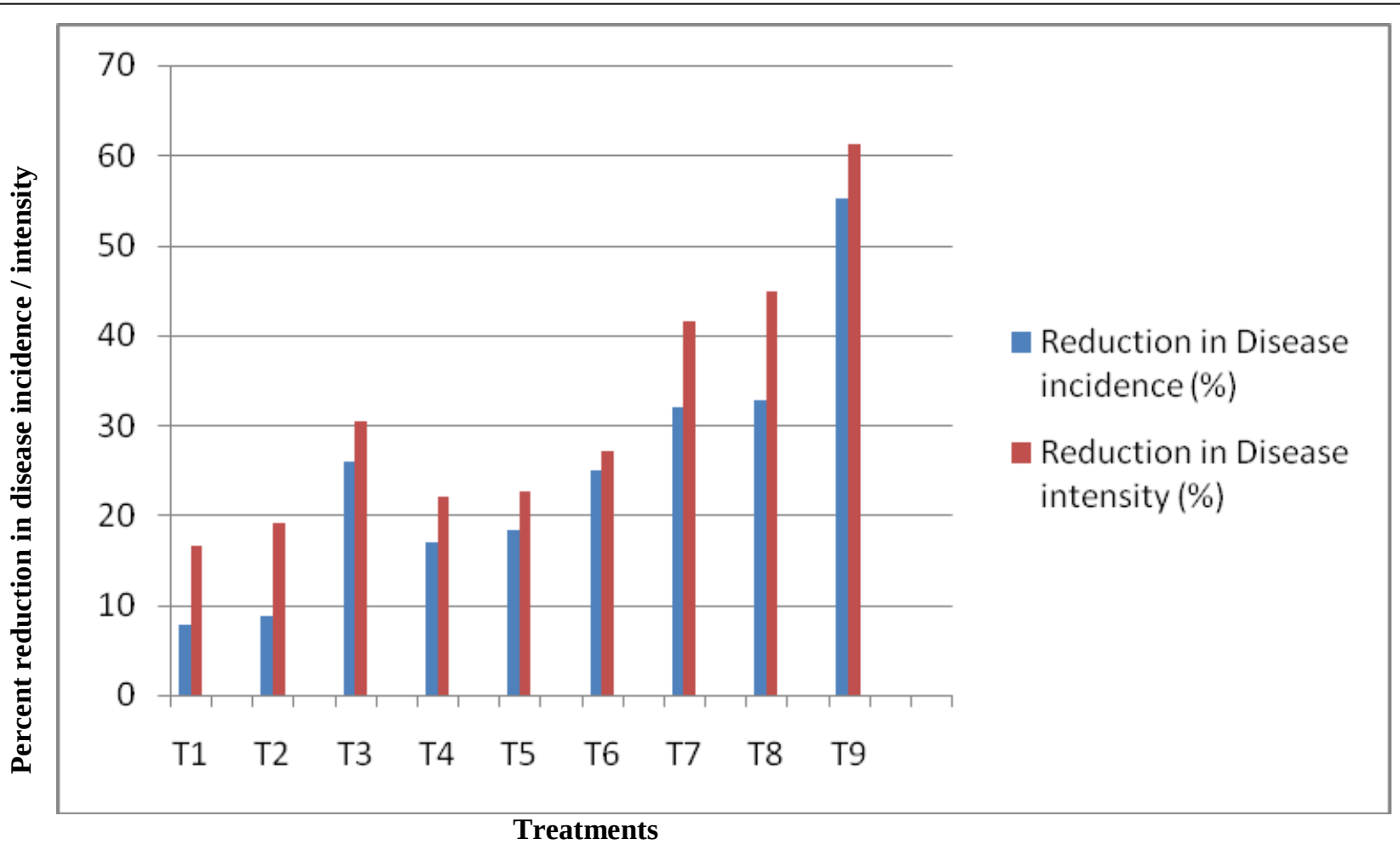


Fig. 11: Reduction in disease incidence and disease intensity over control as a effect of homeopathic drugs at 10 per cent concentration after second spray

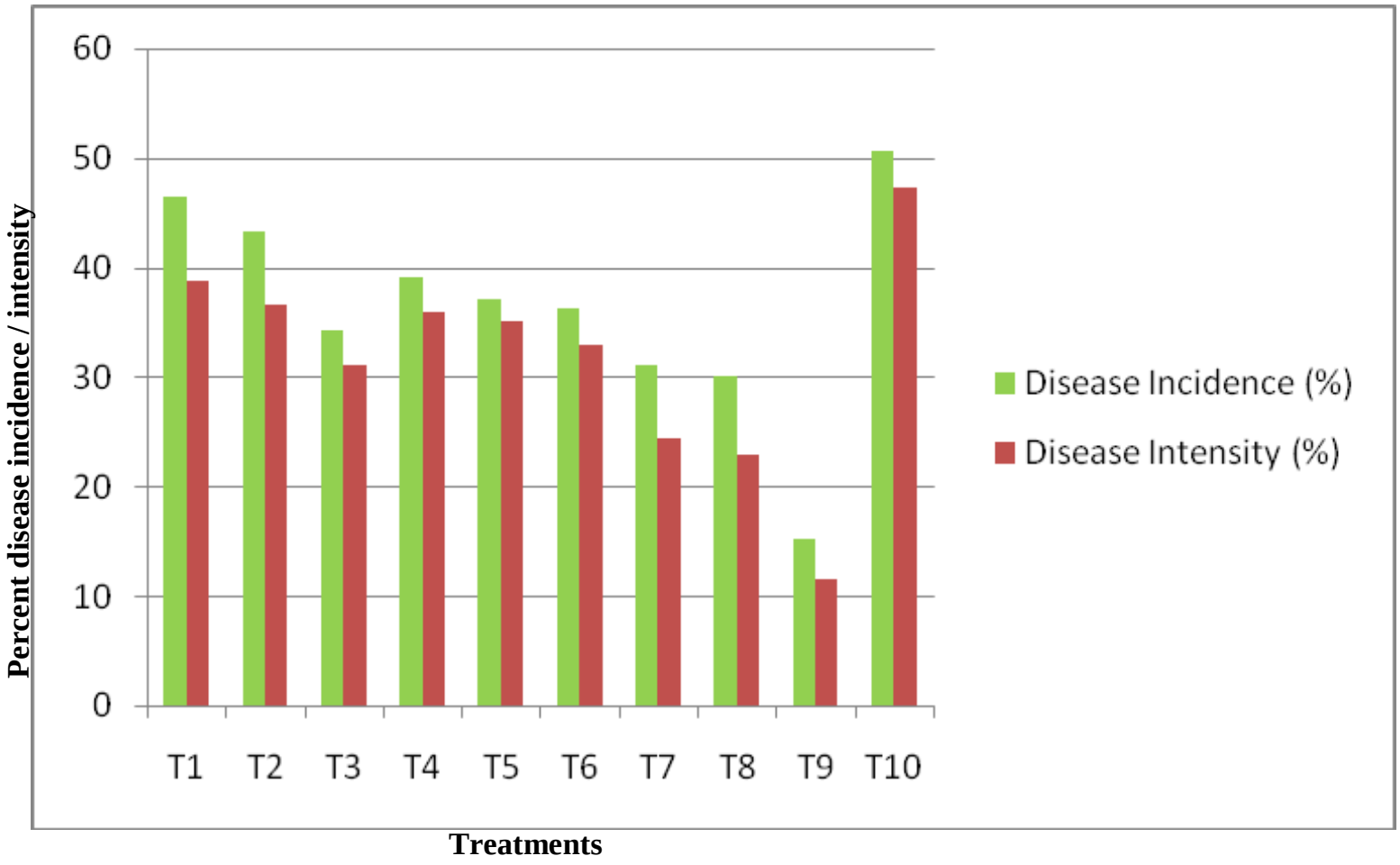


Fig. 12: Effect of homeopathic drugs on disease incidence and disease intensity at 10 per cent concentration after third spray

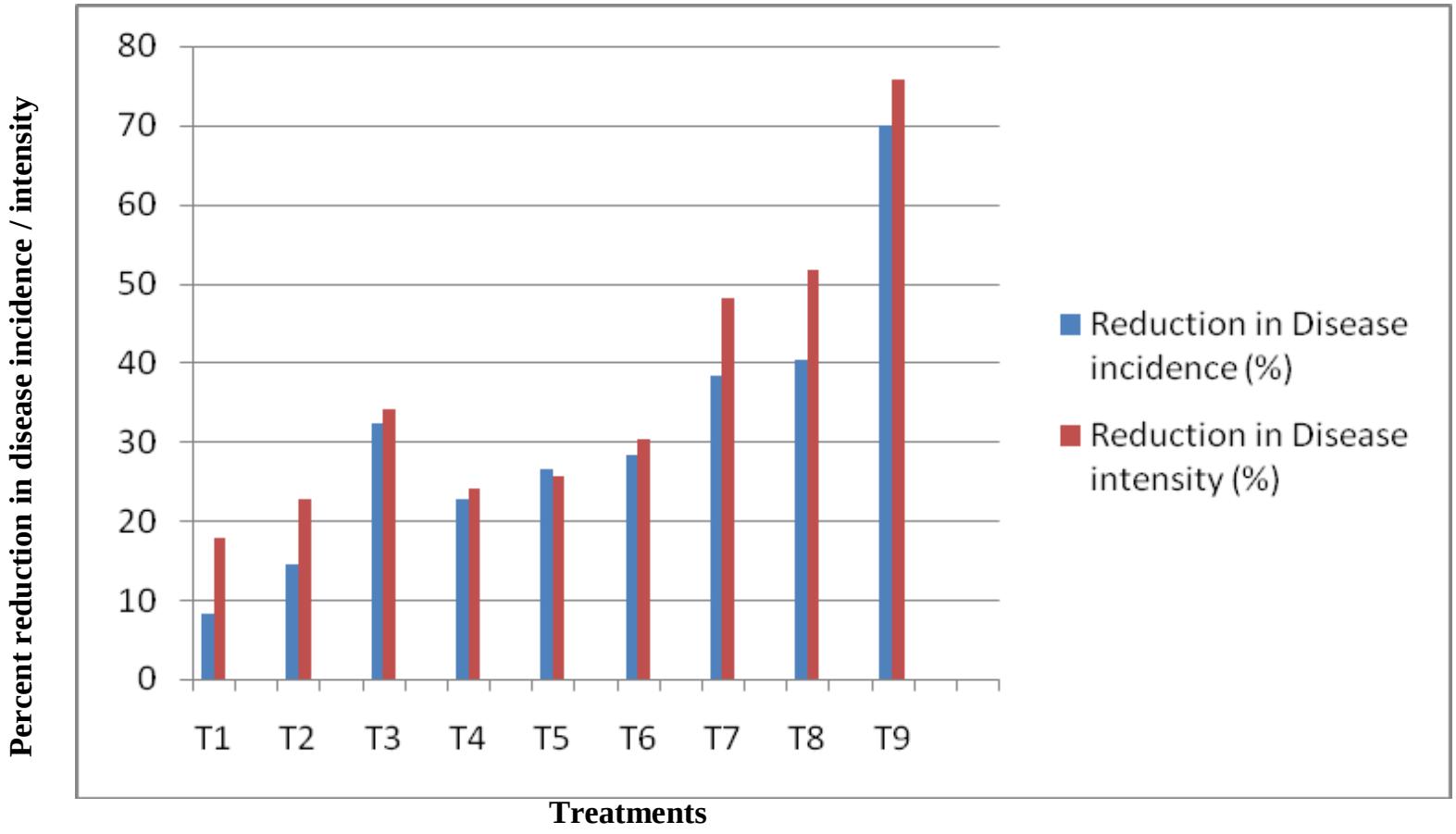


Fig. 13: Reduction in disease incidence and intensity over control as a effect of homeopathic drugs at 10 per cent concentration after third spray

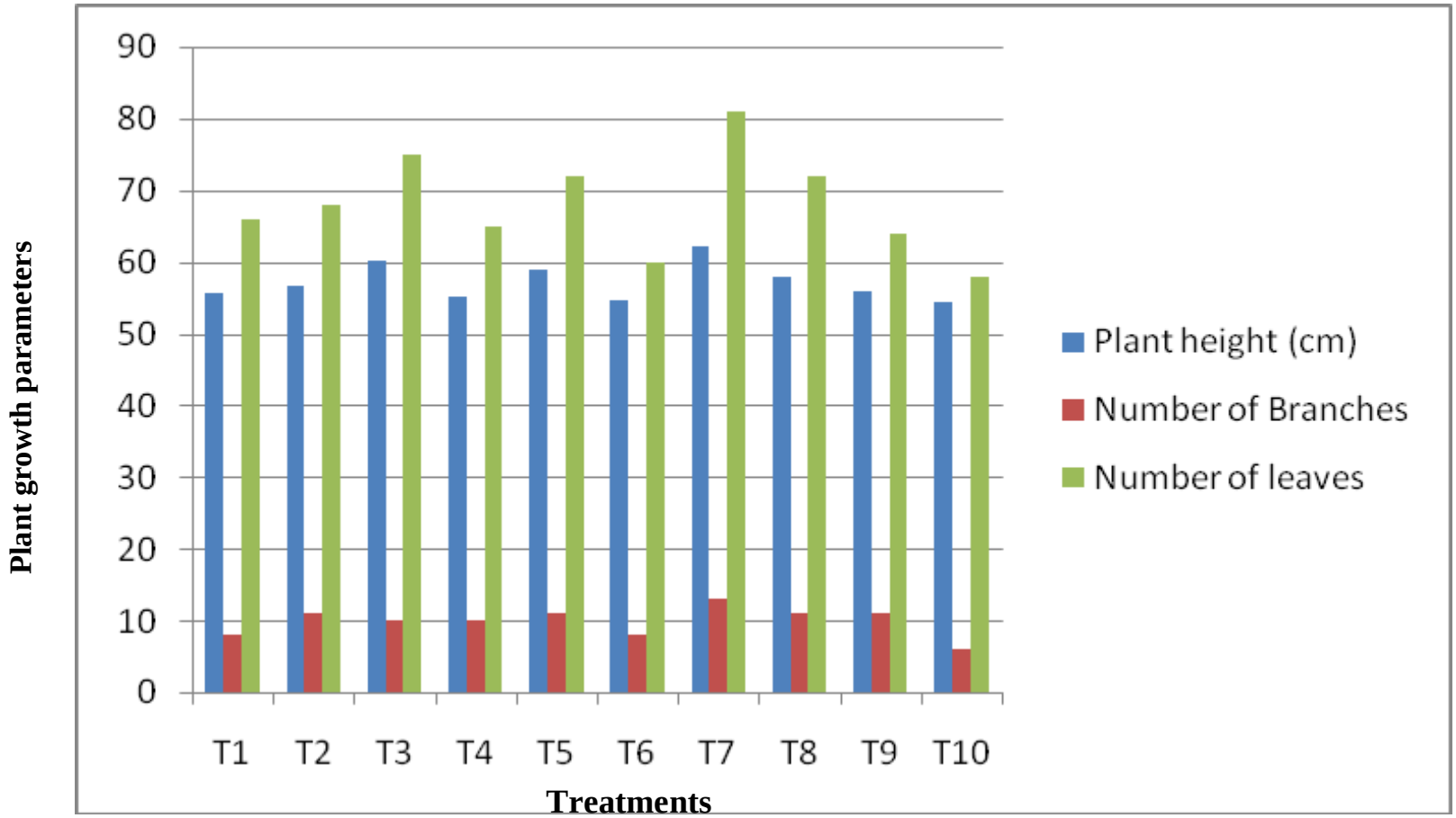


Fig. 14: Effect of spraying of homeopathic drugs on plant growth parameter

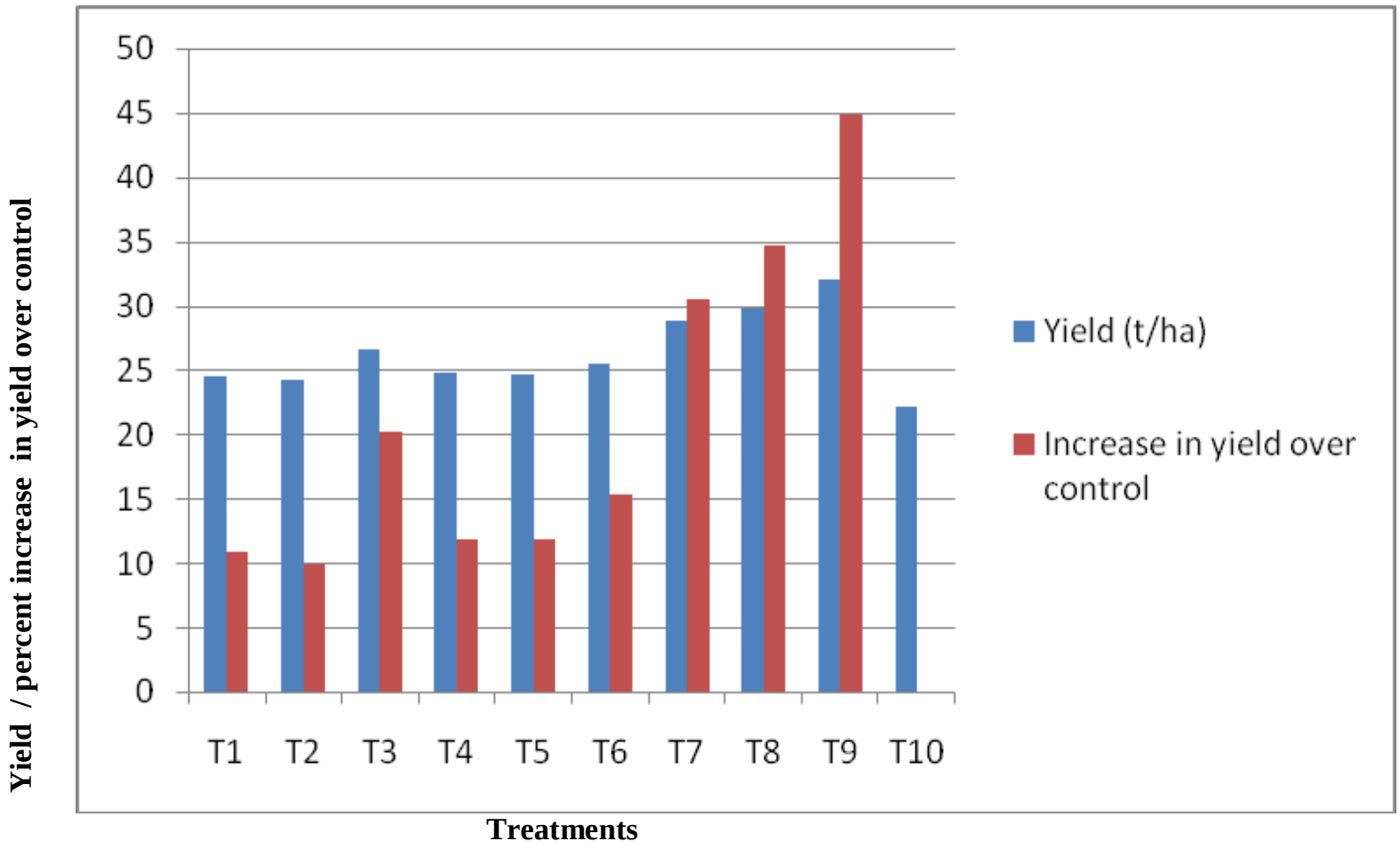


Fig. 15: Effect of spraying of homeopathic drugs on on yield of tomato at 10 per cent concentration.