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In vitro efficacy of chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae* (Patel) Robbs

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Abstract
Mango bacterial leaf spot caused by *Xanthomonas campestris* pv. *mangiferaeindicae* is one of the most destructive diseases inflicting considerable qualitative and quantitative losses. *Invitro* efficacy of chemicals and antibiotics, namely copper sulphate, copper oxychloride, streptocycline, mancozeb, 2-bromo 2 nitro propane 1,3 diol, carbendazim, streptocycline + copper sulphate, copper sulphate + 2 bromo 2 nitro propane 1,3 diol, mancozeb + copper oxychloride was evaluated for the management of bacterial leaf spot of mango caused by *Xanthomonas campestris* pv. *mangiferaeindicae*. The results showed that all the tested chemicals and antibiotics at different concentrations significantly inhibit the growth of the bacteria compared to control. Streptocycline 500 ppm was found most effective inhibiting the bacterial growth (30.66%) of *Xanthomonas campestris* pv. *mangiferaeindicae* followed by streptocycline + coppersulphate (28.11%) at 250 + 2000 ppm and carbendazim + streptocycline (27.33%) at 1000 + 500 ppm. Copper sulphate was found least effective with 10.33% inhibition over control.

Keywords: *Xanthomonas campestris* pv. *mangiferaeindicae*, inhibition zone, chemicals, antibiotics, inhibition zone method

Introduction
Mango (*Mangifera indica* L.) is one of the most cultivated and commercial tropical fruits in the world belonging to family Anacardiaceae. Bacterial leaf spot of mango was reported for the first time in India from Poona and Dharwar (Patel *et al*., 1948) [7]. Bacterial leaf spot of mango is caused by *Xanthomonas campestris* pv. *mangiferaeindicae* (Robbs *et al*., 1974) [9]. It is very difficult to control, and usually becomes a limiting factor for mango industries, when fungal diseases and other pests can be managed at acceptable levels. Epidemics occurred in most of the mango producing areas of South Africa, causing almost 100 percent fruit loss (Gagnevin and Pruvost, 2001) [1]. Khatua *et al*. (2013) [3] reported that mango canker caused by *Xanthomonas campestris* pv. *mangiferaeindicae*, was one of the important disease causing considerable losses and an upcoming threat in mango cultivation in West Bengal. During the summer months, disease appears in most serious forms in many production areas of India (Kishun, 1982) [4].
Among the several strategies available for disease management, protection through chemicals is a vital approach and is more assured to the farmers. Control of mango bacterial leaf spot with copper based fungicides have been reported by several workers (Misra, 1992; Thirumalesh *et al.*, 2012) [6, 11]. An integrated control scheme by the production of disease free nursery plant material, protection of plants from wind driven rain by the use of wind breaks, destruction of the potential source of inoculum and reduction of epiphytic bacterial populations by copper sprays was proposed (Gagnevin and Pruvost, 2001) [1]. *In vitro* studies of Thirumalesh *et al*. (2011) [10] showed the antibiotics ciprofloxacin, tetracycline, and kanamycin were most effective against the four tested strains of Xanthomonas campestris pv. mangiferaeindicae whereas chloramphenicol, copper sulphate, copper oxychloride and commercial bacterinashak also exerted antibacterial activity. Rashid *et al*., (2016) [8] reported that ridomil gold 3% was very effective in managing bacterial leaf spot of mango.

Materials and Methods
The present study was conducted in laboratory of Plant Pathology, college of Agriculture, Vasantrao naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2018-19.

The details of materials used and the methodology adopted in the present investigation are briefly described below:

Treatments details: T1-Copper sulphate, T2-Copper oxychloride, T3- Streptocycline T4- Mancozeb, T5-2 bromo 2 nitro propane 1,3 diol, T6-Carbendazim, T7-Streptocycline + copper sulphate, T8-Copper sulphate + 2 bromo 2 nitro propane, 1,3 diol T9-Mancozeb + copper oxy chloride, T10-Carbendazim + streptocycline and T11-Control. The treatments were with three replications and different concentrations, the statistical design used was CRD.

The test chemicals and antibiotic solutions of various concentrations in distilled water were prepared. The filter paper discs (Whatman No. 42) of 5 mm in diameter were soaked separately in the respective chemical and antibiotic solutions for 5-10 minutes and put in the center onto solidified bacterium seeded NA medium in Petri plates. The inoculated plates were kept in the refrigerator at 40 C for 4 hours to allow diffusion of the chemical and antibiotic into NA medium. Untreated control plates filled with the test bacterium seeded NA and inoculated with filter paper disc soaked in distilled water were maintained.

The Petri plates after treatment were incubated at 28 ± 2 °C for 48 hours. Observations on zone of inhibition was recorded and percent inhibition over control was calculated using the given formula.

$$I = \frac{C - T}{C} \times 100$$

Where

I = Percent inhibition,

C = Growth of test pathogen in control plate,

T = growth of test pathogen in treatment plate

Results and Discussion

Results revealed that highest mean bacterial inhibition zone was made by streptocycline treatment 22.40 mm in diameter followed by carbendazim + streptocycline treatment with a mean inhibition zone of 21.96 mm. The minimum mean inhibition zone was shown by copper sulphate treatment with 14.20 mm in diameter. Among individual concentrations the maximum inhibition zone was made by streptocycline (500 ppm) 27.6 mm in diameter followed by streptocycline + copper sulphate (250 + 2000 ppm) 25.3 mm in diameter. Streptocycline (500 ppm) and streptocycline + copper sulphate (250 + 2000 ppm) inhibited the growth of the bacteria to an extent of 30.66 and 28.11 percent over control followed by carbendazim + streptocycline (1000+500 ppm) with an inhibition growth of bacteria (24.60 mm) and percent inhibition over control (27.33). The results were shown in Table 1, Fig 1 and 2, plate 1, 2 and 3.

Table 1: *In vitro* evaluation of different chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae.*

Treatments	Conc. (ppm)	Inhibition zone (mm)*	Inhibition percent over control	Mean inhibition zone
T1-Copper sulphate	1000	9.30	10.33 (18.74)	14.20 (22.13)
	1500	12.30	13.66 (21.69)	
	2000	21.00	23.33 (28.88)	
T2-Copper oxychloride	2000	19.60	21.77 (27.81)	21.60 (27.69)
	2500	22.00	24.44 (29.62)	
	3000	23.20	25.77 (30.50)	
T3- Streptocycline	100	17.30	19.22 (26.00)	22.40 (28.24)
	250	22.30	24.77 (29.84)	
	500	27.60	30.66 (33.62)	
T4-Mancozeb	2000	16.30	18.11 (25.18)	19.73 (26.37)
	2500	20.60	22.88 (28.57)	
	3000	22.30	24.77 (29.84)	
T5-2 bromo 2 nitro propane 1,3 diol	100	14.30	15.88 (23.48)	16.63 (24.06)
	250	17.00	18.88 (25.75)	
	500	18.60	20.66 (27.03)	
T6-Carbendazim	1000	15.30	17.00 (24.35)	18.73 (25.64)
	1500	19.30	21.44 (27.58)	
	2000	21.60	24.00 (29.33)	
T7-Streptocycline + copper sulphate	250 + 1000	17.30	19.22 (26.00)	21.30 (27.48)
	250 + 1500	21.30	23.66 (29.10)	
	250 + 2000	25.30	28.11 (32.01)	
T8-Copper sulphate + 2 bromo 2 nitro propane 1,3 diol	1000 + 250	16.00	17.77 (24.93)	19.06 (25.88)
	1500 + 250	19.60	21.77 (27.81)	
	2000 + 250	21.60	24.00 (29.33)	
T9-Mancozeb + copper oxy chloride	1000 + 1000	14.10	15.66 (23.31)	18.53 (25.49)
	1000 + 1500	19.00	21.11 (27.35)	
	1000 + 2000	22.50	25.00 (30.00)	
T10-Carbendazim + streptocycline	1000 + 100	19.50	21.66 (27.73)	21.96 (27.94)
	1000 + 250	21.80	24.22 (29.48)	
	1000 + 500	24.60	27.33 (31.51)	
T11-Control	-	90.00	0.00	0.00
S.E.±				0.92
C.D. at 1%				2.22

*Mean of three replications; Figures in parenthesis are arc sin values.

Results obtained were in accordance with earlier workers, Misra and Om Prakash (1992) [6]. Venugopal (1983) [12] studied the *in vitro* sensitivity of different isolates of *Xanthomonas campestris* pv. *mangiferaeindicae* to streptomycin and paushamycin @ 100 and 250 ppm concentrations, respectively. Jambenal *et al*., (2011) [2] tested *in vitro* efficacy of different chemicals where the streptocycline (500 ppm) + copper oxychloride (2000 ppm) produced maximum inhibition zone (24.97 mm) followed by streptocycline 500 ppm (22.40 mm) against *Xanthomonas campestris* pv. *viticola* causing bacterial leaf spot of grape. Thirumalesh (2012) [11] recorded the maximum inhibition zone *in vitro* produced by bactrinashak (25.00 mm) followed by streptocyline (19.67 mm) whereas, by mixing half concentrations of antibiotics and chemicals, carbendazim + bactrinashak (21.33 mm) showed maximum inhibition zone followed by copper sulphate + streptocycline (18.67 mm) against *Xanthomonas campestris* pv. *mangiferaeindicae.* Kumar *et al* (2017) [5] reported that streptocycline (750 ppm) with the inhibition of 2.69 cm was more effective and among combinations copper oxychloride (0.3%) + streptocycline (750 ppm) was found significantly very effective with maximum inhibition zone of 3.41 cm against *Xanthomonas axonopodis* pv. *glycines.*

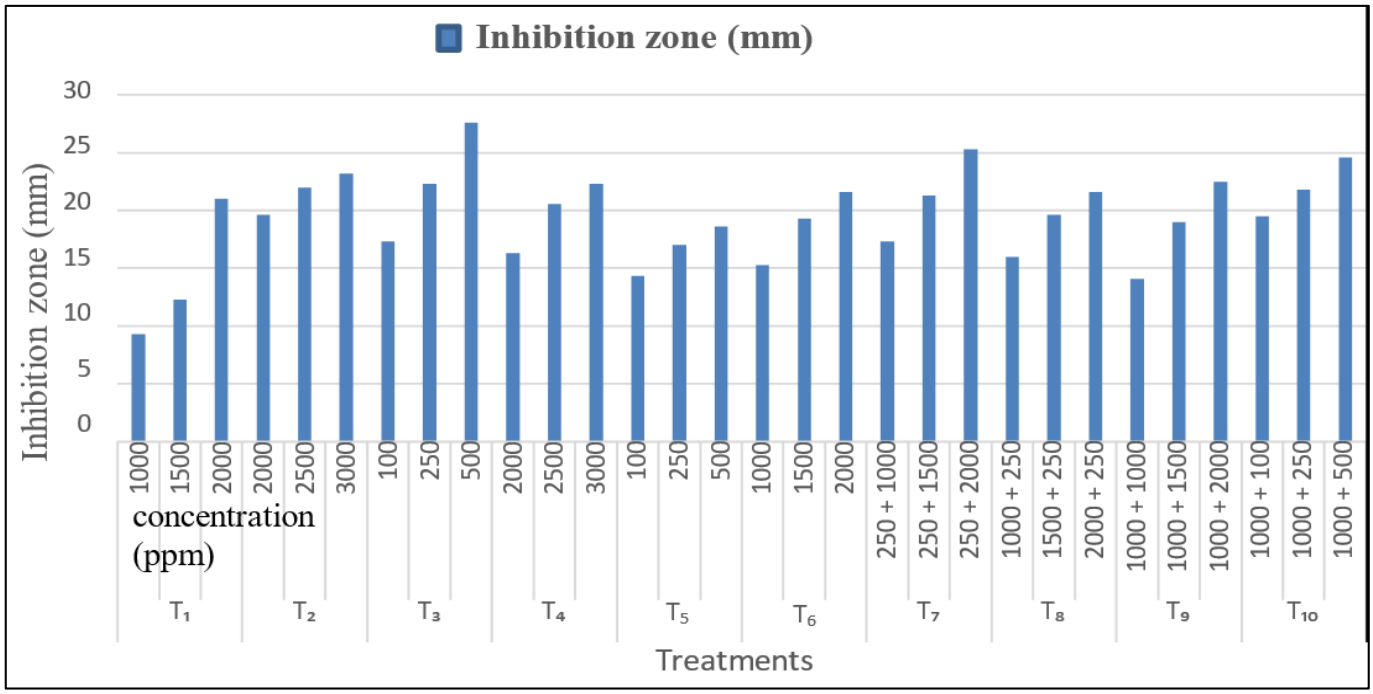

Fig 1: *In vitro* effect of chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae* at different level of concentration (ppm)

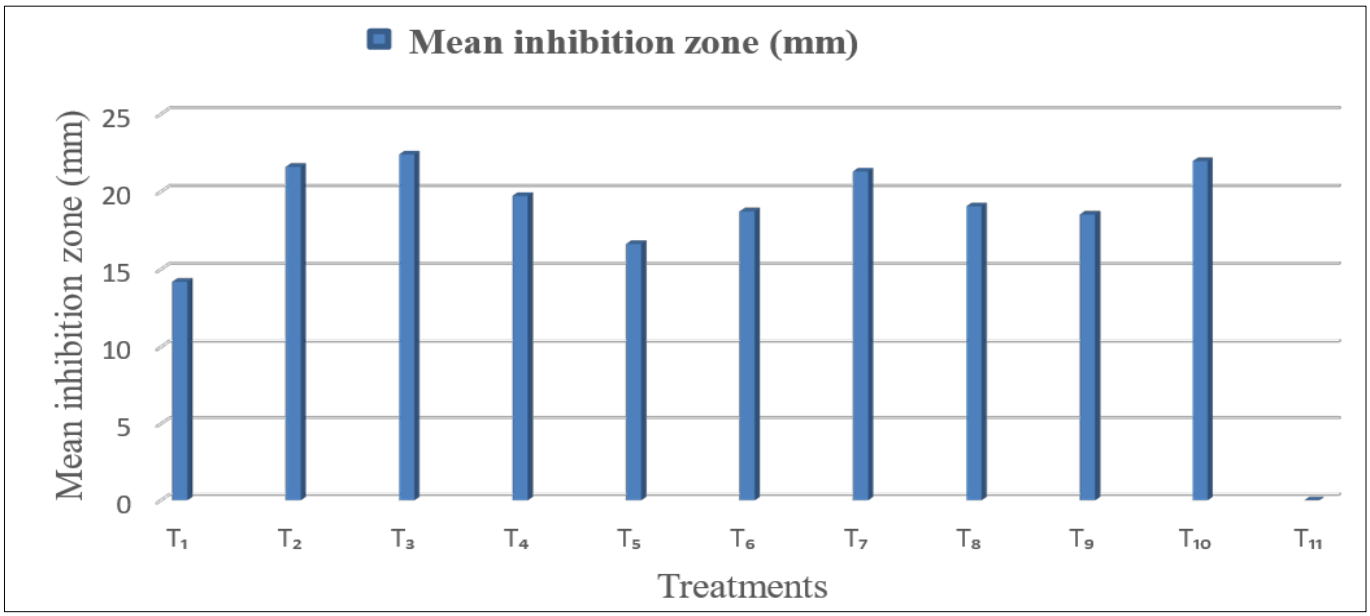

Fig 2: Mean inhibition zone (mm) produced *in vitro* against *Xanthomonas campestris* pv. *mangiferaeindicae* by different chemicals and antibiotics.

Plate 1: *In vitro* evaluation of different chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae* at first level of concentration.

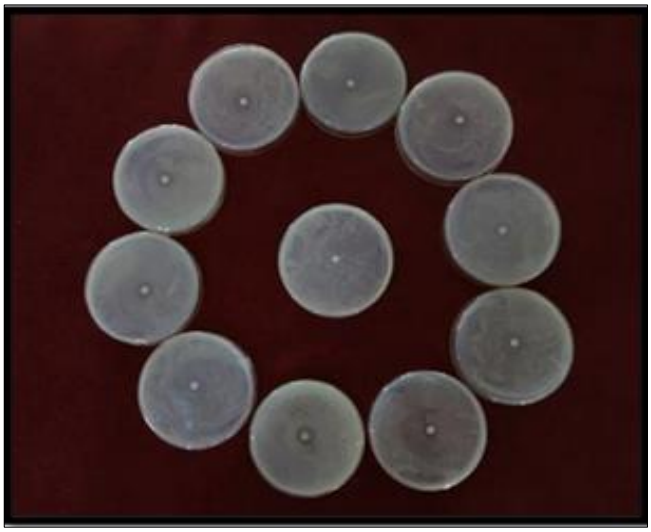

Plate 2: *In vitro* evaluation of different chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae* at second level of concentration

Plate 3: *In vitro* evaluation of different chemicals and antibiotics against *Xanthomonas campestris* pv. *mangiferaeindicae* at third level of concentration

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