LR-4889
[1-6]

RESEARCH ARTICLE Legume Research- An International Journal, Volume Issue : ()

Management of Bacterial Blight of Clusterbean Caused by *Xanthomonas axonopodis* pv. *cyamopsidis* under Field Conditions

Anita Jat, P.S. Shekhawat, K.K. Saini[1]

10.18805/LR-4889

ABSTRACT

Background: Bacterial blight pathogen (*Xanthomonas axonopodis* pv. *cyamopsidis*) of clusterbean causes considerable damage every year during *Kharif* season and sometimes become very severe, which results in heavy loss in grain yield.

Methods: On the basis of *in vitro* studies, most effective botanical, antibiotic and fungicide at highest concentration were used as individual and its combinations in field experiment during two consecutive years *Kharif* 2018 and 2019. Seeds of clusterbean cultivar RGC-936 were artificially inoculated with *X. axonopodis* pv. *cyamopsidis* by soaking in bacterial cell suspension (2.5×10^8 cfu/ml) for 30 min and dried under shade. The artificially inoculated seeds were used for sowing in field trial

Result: Field evaluation, the combined treatment, seed treatment with streptocycline @ 250 ppm followed two foliar sprays of streptocycline @ 250 ppm and 1st foliar spray of copper oxychloride @ 0.3 per cent and 2nd foliar spray of streptocycline @ 250 ppm at 15 days interval was found the most effective in reducing the per cent disease severity and increasing the grain and fodder yield in clusterbean.

Key words: Bacterial blight, Clusterbean, *Cyamopsis tetragonaloba*, Severity.

INTRODUCTION

Clusterbean [*Cyamopsis tetragonaloba* (L.) Taub.] is an important annual legume crop of *Kharif* season in arid and semi-arid regions of the Indian subcontinent. It is a self-pollinated, short duration legume crop generally cultivated under resource constrained conditions on marginal and sub marginal lands (Kumar, 2005). Clusterbean belongs to the tribe Indigoferae of the Leguminosae (Fabaceae) family with diploid chromosome number 2 n=14. The crop is known for drought tolerance having deep root system (Kumar and Rodge, 2012). The area under clusterbean production in India is 4.26 million ha with a production of 2.42 million tonnes and productivity of 567 kg/ha (Directorate of Economics and Statistics, Anonymous, 2020). Rajasthan is the biggest clusterbean producing state about 80 per cent of the total clusterbean production in the country. In Rajasthan, area under the clusterbean 35.30 lakh hectare with production of 14.04 lakh tonnes and productivity 398 kg/ha (Directorate of Economics and Statistics, Anonymany 2020).

The major diseases of clusterbean are bacterial blight (*Xanthomonas axonopodis* pv. *cyamopsidis*). One of the most destructive causes bacterial blight and this is a wide spread diseases which may cause average losses of 58-68 per cent (Amin *et al*., 2017).

MATERIALS AND METHODS

On the basis of *in vitro* studies, most effective botanicals, antibiotics and fungicides at highest concentration were used as individual and in combinations in field experiment during the two consecutive years *Kharif* 2018 and 2019. Seeds of clusterbean cultivar RGC-936, artificially inoculated with *X. axonopodis* pv. *cyamopsidis* by soaking in bacterial cell suspension (2.5×10^8c fu/ml) for 30 min and dried under shade (Rathore, 2006). The inoculum treated seeds were used for sowing in field trial. The first foliar spraying of each treatment was done 36 days after sowing disease was noticed and subsequently second spraying was followed at 15 days interval. Observations on disease severity was recorded before spray, seven days after first spray and seven days after second spray randomly selected plants from each plot using 0-5 point scale following the method of Rathore (2006). Grain yield per plot was recorded from each plot. In field experiment, the following treatments were set up using randomized block design (RBD) with three replications, respectively.

Seed treatment with streptocycline @ 250 ppm followed by foliar spray of followings at 15 days interval

T1: 1st foliar spray of datura extract @ 150 ml/litre water +2nd foliar spray of streptocycline @ 250 ppm/litre water.

T2: 1st foliar spray of datura extract @ 150 ml/litre water +2nd foliar spray of copper oxychloride @ 3.0 g/litre water.

Division of Plant Pathology, Rajasthan Agricultural Research Institute, SKN Agriculture University, Durgapura-302 018, Jaipur, Rajasthan, India.
[1]Agriculture University, Jodhpur-342 304, Rajasthan, India.

Corresponding Author: Anita Jat, Division of Plant Pathology, Rajasthan Agricultural Research Institute, SKN Agriculture University, Durgapura-302 018, Jaipur, Rajasthan, India. Email: anitajat670@gmail.com

How to cite this article: Jat, A., Shekhawat, P.S. and Saini, K.K. (2022). Management of Bacterial Blight of Clusterbean Caused by *Xanthomonas axonopodis* pv. *cyamopsidis* under Field Conditions. Legume Research. DOI: 10.18805/LR-4889.

Submitted: 07-02-2022 **Accepted:** 31-10-2022 **Online:** 23-11-2022

T3: 1st foliar spray of neem leaf extract @ 150 ml/litre water +2nd foliar spray of datura extract @ 150 ml/litre water.
T4: 1st foliar spray of streptocycline @ 250 ppm/litre water +2nd foliar spray of streptocycline @ 250 ppm/litre water.
T5: 1st foliar spray of copper oxychloride @ 3.0 g/litre water +2nd foliar spray of streptocycline @ 250 ppm/litre water.
T6: 1st foliar spray of copper oxychloride @ 3.0 g/litre water +2nd foliar spray of copper oxychloride @ 3.0 g/litre water.
T7: 1st foliar spray of neem leaf extract @ 150 ml/litre water +2nd foliar spray of neem leaf extract @ 150 ml/litre water.
T8: 1st foliar spray of neem leaf extract @ 150 ml/litre water +2nd foliar spray of copper oxychloride @ 3.0 g/litre water.
T9: 1st foliar spray of neem leaf extract @ 150 ml/litre water +2nd foliar spray of streptocycline @ 250 ppm/litre water.
T10: 1st foliar spray of datura extract @ 150 ml/litre water+2nd foliar spray of datura extract @ 150 ml/litre water.
T11: Control.

Experiment details of field trial

1. Experimental design : RBD (Randomized block design)
2. Total no of treatments : 11
3. Number of replication : 3
4. Plot size : 3 × 2 m^2
5. Spacing : 30 × 10 cm
6. Variety : RGC-936

The per cent efficacy of disease management (PDM) was calculated by following formula:

$$PDM = \frac{\text{Infection index in control - Infection index in treatment}}{\text{Infection index in control}} \times 100$$

Seed yield was recorded for each treatment at harvest and per cent increase in yield was calculated by using following formula:

$$\text{Per cent increase in yield} = \frac{\text{Yield in treatment - Yield in control}}{\text{Yield in control}} \times 100$$

RESULTS AND DISCUSSION

On the basis of cage house studies, the most effective botanical, antibiotic and fungicides were further tested alone as well as in combinations against the bacterial blight of clusterbean under field conditions at Agricultural Farm, RARI, Durgapura during *kharif* season 2018 and 2019. The artificially inoculated seeds with bacterial suspension were used for the experimentation and foliar spray with bacterial suspension were applied twice in a day on 30 days old plants. The seed treatment with streptocycline @ 250 ppm was common for each treatment. The two foliar sprays of fungicides, antibiotics and botanicals were applied individually as well as in combinations first at three days after last inoculation and repeated after 15 days. The per cent disease severity was recorded before spray, seven days after first spray and seven days after second spray. The grain and fodder yield were recorded at harvest.

Two years pooled data presented in the Table 1 and 2 revealed that all the tested botanicals, antibiotics and fungicides were found significantly superior over untreated check in both reducing the disease and increasing the yield when tested individually as well as in combinations. The data revealed that there was no significant difference in per cent disease severity (PDS) among the treatments when recorded before the time of first spray because it was initiation of the disease. However, both the treatments of different spraying schedules showed significant effect on per cent disease severity over the check at seven days after first spray (Table 1 and Fig 1). The minimum per cent disease severity was recorded in treatment T4- two foliar sprays of streptocycline @ 250 ppm with 6.67, 8.00 and 7.33 followed by T5- first foliar spray copper oxychloride @ 0.3 per cent and second foliar spray streptocycline @ 250 ppm (9.33, 10.67 and 10.00 PDS) and T6- two foliar sprays of copper oxychloride @ 0.3 per cent (13.33, 14.67 and 14.00 PDS) during *Kharif* season 2018, 2019 and pooled respectively. The disease severity was highest in T11- control (32.00, 40.00 and 36.00) at seven days after first spray during both the years and pooled respectively.

Similarly, the minimum per cent disease severity was also recorded with two foliar sprays of streptocycline @ 250 ppm when recorded at seven days after second spray with 10.67, 12.00 and 11.33 followed by first foliar spray with copper oxychloride @ 0.3 per cent and second with streptocycline @ 250 ppm (14.67, 16.00 and 15.33 PDS) and two foliar sprays of copper oxychloride (16.00, 17.33 and 16.67 PDS) during *Kharif* season 2018, 2019 and pooled respectively. The treatment T5 was found at par in efficacy with treatment T4 (Table 1 and Fig 1).

The data presented in the Table 1, Fig 1 revealed that all the fungicides, antibiotics and botanicals were found significantly superior over untreated check in reducing the disease when tested individually as well as in combination. Two foliar sprays of streptocycline @ 250 ppm were found best with minimum (12.00, 13.33 and 12.67 PDS) and maximum 73.96 per cent disease reduction over the check followed by first foliar spray with copper oxychloride @ 0.3 per cent and second foliar spray with streptocycline @ 250 ppm (16.00, 17.33, 16.67 PDS and 65.74 PDROC) and two foliar sprays with copper oxychloride @ 0.3 per cent with 18.67, 20.00, 19.33 per cent disease severity with 60.28 per cent disease control over the check during *kharif* 2018, 2019 and pooled respectively. The treatment T5- (1st foliar spray with copper oxychloride @ 0.3 per cent and second foliar spray with streptocycline @ 250 ppm) was found at par in efficacy with treatment T4- (two foliar sprays with streptocycline @ 250 ppm at 15 days interval).

The data on grain and fodder yield of both *Kharif* season 2018 and 2019 and pooled presented in Table 2 and Fig 2 revealed that the maximum grain and fodder yield (12.68 and 28.06 q/ha) were recorded in T4-(two foliar sprays with streptocycline @ 250 ppm) with 243.63 and 115.34 per cent increase in grain and fodder yield respectively over the

Table 1: Effect of seed treatment with streptocycline @ 250 ppm followed by foliar spray on management of bacterial blight of clusterbean during *kharif* 2018 and 2019 under field conditions.

Treatments	Per cent disease severity												Per cent disease reduction over control
	Before spray			7 Days after first spray			7 Days after second spray			Final			
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	
T1	10.67	13.33	12.00	20.00	21.33	20.67	25.33	26.67	26.00	26.67	28.00	27.33	43.84
	(18.99)*	(21.37)	(20.23)	(26.49)	(27.36)	(26.93)	(30.12)	(30.99)	(30.56)	(31.08)	(31.91)	(31.50)	
T2	12.00	14.67	13.33	21.33	22.67	22.00	26.67	28.00	27.33	29.33	30.67	30.00	38.36
	(20.09)	(22.47)	(21.33)	(27.49)	(28.41)	(27.96)	(31.08)	(31.91)	(31.50)	(32.78)	(33.59)	(33.19)	
T3	14.67	17.33	16.00	24.00	24.00	24.00	33.33	32.00	32.67	32.00	34.67	33.33	31.51
	(22.47)	(24.57)	(23.55)	(29.28)	(29.28)	(29.28)	(35.26)	(34.42)	(34.84)	(34.42)	(36.02)	(35.22)	
T4	4.00	4.00	4.00	6.67	8.00	7.33	10.67	12.00	11.33	12.00	13.33	12.67	73.96
	(11.54)	(11.54)	(11.54)	(14.80)	(16.08)	(15.47)	(18.81)	(20.09)	(19.48)	(20.09)	(21.09)	(20.60)	
T5	5.33	6.67	6.00	9.33	10.67	10.00	14.67	16.00	15.33	16.00	17.33	16.67	65.74
	(13.17)	(14.80)	(14.05)	(17.71)	(18.81)	(18.28)	(22.19)	(23.47)	(22.86)	(23.47)	(24.39)	(23.94)	
T6	6.67	8.00	7.33	13.33	14.67	14.00	16.00	17.33	16.67	18.67	20.00	19.33	60.28
	(14.80)	(16.08)	(15.47)	(21.37)	(22.47)	(21.94)	(23.47)	(24.39)	(23.94)	(25.57)	(26.49)	(26.04)	
T7	13.33	14.67	14.00	25.33	21.33	23.33	28.00	29.33	28.67	30.67	32.00	31.33	35.62
	(21.37)	(22.47)	(21.33)	(30.21)	(27.49)	(28.88)	(31.85)	(32.72)	(32.29)	(33.55)	(34.42)	(33.99)	
T8	9.33	12.00	10.67	17.33	18.67	18.00	22.67	24.00	23.33	25.33	26.67	26.00	46.57
	(17.36)	(20.27)	(18.99)	(24.57)	(25.50)	(25.04)	(28.41)	(29.28)	(28.85)	(30.12)	(30.99)	(30.56)	
T9	8.00	10.67	9.33	16.00	17.33	16.67	21.33	22.67	22.00	24.00	25.33	24.67	49.31
	(16.08)	(18.81)	(17.53)	(23.47)	(24.57)	(24.04)	(27.49)	(28.36)	(27.93)	(29.28)	(30.12)	(29.70)	
T10	16.00	20.00	18.00	30.67	33.33	32.00	34.67	36.00	35.33	36.00	41.33	38.67	20.54
	(23.47)	(26.49)	(25.04)	(33.62)	(35.23)	(34.43)	(36.02)	(36.85)	(36.44)	(36.80)	(40.01)	(38.44)	
T11	22.67	28.00	25.33	32.00	40.00	36.00	44.00	46.67	45.33	46.67	50.67	48.67	-
	(28.41)	(31.95)	(30.22)	(34.45)	(39.23)	(36.87)	(41.55)	(43.09)	(42.32)	(43.09)	(45.38)	(44.24)	
SEm±	1.33	1.46	1.26	1.30	1.74	1.47	1.84	1.69	1.70	1.66	2.03	1.81	
CD at 5%	NS	NS	NS	3.81	5.07	4.28	5.36	4.92	4.96	4.85	5.94	5.28	
CV%	9.21	8.39	9.34	9.04	8.35	9.98	8.45	9.77	9.00	9.49	9.20	9.14	

All data are mean of three replications. *Figures in parentheses are angular transformed values.

control followed by T5-(1st foliar spray copper oxychloride @ 0.3 per cent +2nd foliar spray streptocycline @ 250 ppm) with 12.08 and 27.50 q/ha and T6-(two foliar sprays with copper oxychloride @ 0.3 per cent) with 11.51 and 26.11q/ha.

The maximum incremental cost benefit ratio of 1:16.88 was computed in the treatment T4-(two foliar sprays with streptocycline @ 250 ppm) followed by T5-(1st foliar spray with copper oxychloride @ 0.3 per cent and second foliar spray with streptocycline @ 250 ppm) with 1:15.70, T6-(two foliar sprays with copper oxychloride @ 0.3 per cent) with 1:14.96 (Table 2).

The present studies indicated that the seed soaking with streptocycline @ 250 ppm for 90 minutes followed by two foliar sprays of streptocycline @ 250 ppm or 1st foliar spray of copper oxychloride @ 0.3 per cent and 2nd foliar spray of streptocycline @ 250 ppm at 15 days interval was

Table 2: Effect of seed treatment with streptocycline @ 250 ppm followed by foliar spray on grain and fodder yield of clusterbean during *kharif* 2018 and 2019 under field conditions.

Treatments	Grain yield (q ha^{-1})			Increase in grain yield over control (%)	Fodder yield (q ha^{-1})			Increase in fodder yield over control (%)	ICBR*
	2018	2019	Pooled		2018	2019	Pooled		
T1	10.98	10.11	10.55	185.90	23.33	21.00	22.17	70.14	1: 8.71
T2	9.23	9.25	9.24	150.40	22.33	20.00	21.17	62.47	1: 6.89
T3	8.48	8.28	8.38	127.10	18.28	17.17	17.72	35.99	1:4.11
T4	13.06	12.30	12.68	243.63	28.33	27.78	28.06	115.34	1:16.88
T5	12.43	11.72	12.08	227.37	28.61	26.39	27.50	111.05	1:15.70
T6	11.92	11.09	11.51	211.92	25.56	26.67	26.11	100.38	1:14.96
T7	9.64	8.47	9.06	145.52	19.44	18.61	19.03	46.04	1:4.86
T8	10.23	9.61	9.92	168.83	24.56	24.17	24.36	86.95	1:7.86
T9	11.06	10.97	11.02	198.64	27.78	25.56	26.67	104.68	1:9.31
T10	7.28	6.28	6.78	83.73	16.67	16.51	16.59	27.32	1:2.33
T11	4.00	3.39	3.69	-	12.78	13.28	13.03	-	-
SEm±	0.62	0.69	0.55	-	1.77	1.36	1.20	-	-
CD at 5%	1.80	2.00	1.61	-	5.16	3.97	3.50	-	-
CV%	7.65	8.45	6.87	-	9.56	8.89	8.70	-	

All data are mean of three replications. *ICBR= Incremental cost benefit ratio.

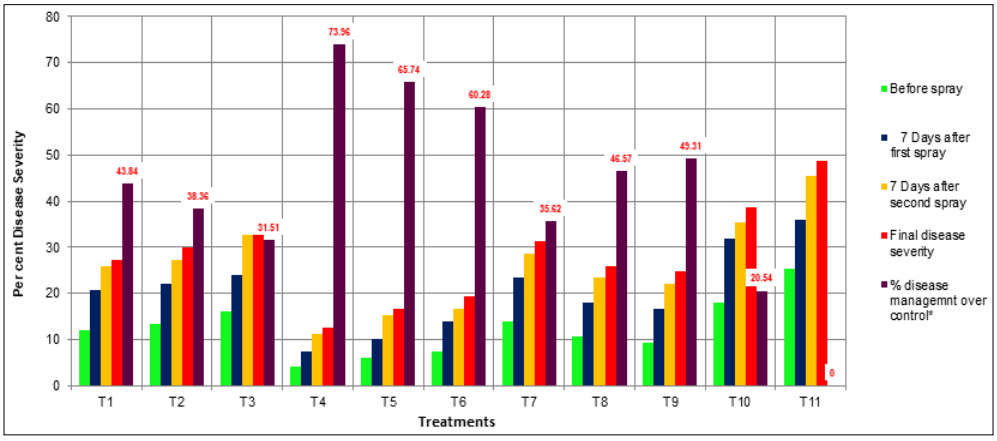

Fig 1: Effect of seed treatment with streptocycline @ 250 ppm followed by foliar spray on management of bacterial blight of clusterbean during *kharif* 2018 and 2019 under field conditions.

T1: 1st spray datura extract +2nd spray streptocycline.
T2: 1st spray datura extract +2nd foliar spray of copper oxychloride.
T3: 1st foliar neem leaf extract +2nd foliar spray of datura extract.
T4: 1st foliar spray streptocycline. +2nd foliar spray streptocycline.
T5: 1st foliar spray copper oxychloride +2nd foliar spray streptocycline.
T6: 1st foliar spray copper oxychloride +2nd foliar spray copper oxychloride.
T7: 1st foliar spray neem leaf extract +2nd foliar spray neem leaf extract.
T8: 1st foliar spray neem leaf extract. +2nd foliar spray of copper oxychloride.
T9: 1st foliar spray neem leaf extract +2nd foliar spray streptocycline.
T10: 1st foliar spray datura extract +2nd foliar spray datura extract.
T11: Control.

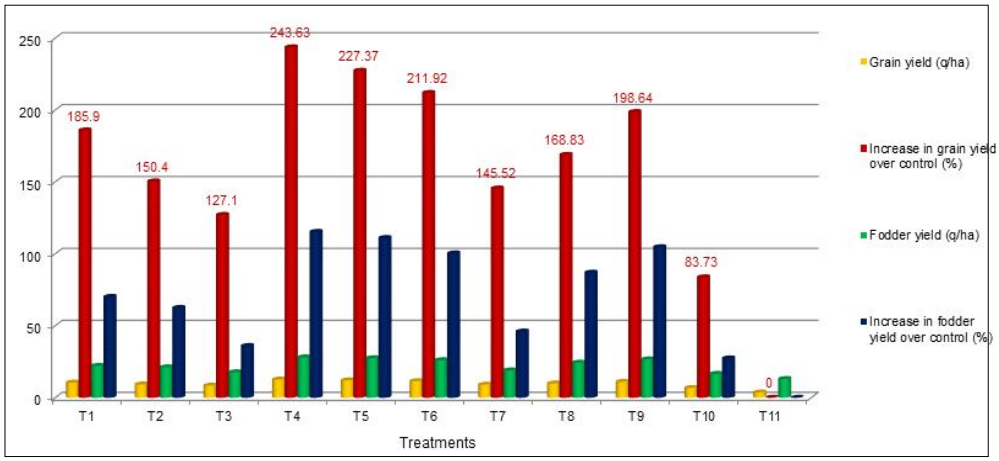

Fig 2: Effect of seed treatment with streptocycline @ 250 ppm followed by foliar spray on grain and fodder yield of clusterbean during *kharif* 2018 and 2019 under field conditions.

T1: 1st spray datura extract +2nd spray streptocycline.
T2: 1st spray datura extract +2nd foliar spray of copper oxychloride.
T3: 1st foliar neem leaf extract +2nd foliar spray of datura extract.
T4: 1st foliar spray streptocycline. +2nd foliar spray streptocycline.
T5: 1st foliar spray copper oxychloride +2nd foliar spray streptocycline.
T6: 1st foliar spray copper oxychloride +2nd foliar spray copper oxychloride.
T7: 1st foliar spray neem leaf extract +2nd foliar spray neem leaf extract.
T8: 1st foliar spray neem leaf extract. +2nd foliar spray of copper oxychloride.
T9: 1st foliar spray neem leaf extract +2nd foliar spray streptocycline.
T10: 1st foliar spray datura extract +2nd foliar spray datura extract.
T11: Control.

found the most effective in reducing the per cent disease severity and increasing the grain and fodder yield in clusterbean.

Earlier the scientist Gupta (1991), Thammaiah and Khan (1995), Yenjerappa *et al.* (2004), Kumar *et al*. (2009), Yenjerappa *et al*. (2011), Jambenal *et al*. (2011), Jagtap *et al*. (2012), Lokesh *et al*. (2014), Antre *et al.* (2016), Bala *et al*. (2017), Kumar and Jahangirdar (2017), Kumhar *et al.* (2018), Prasad *et al*. (2018), Bagari *et al.* (2019) and Madavi *et al*. (2020) also reported the spray combination of streptocycline (250 ppm) + copper oxychloride (2000 ppm) as the best practice in management of bacterial blight at 15 days interval and increase the yield.

CONCLUSION

In field evaluation, the combined treatment, seed treatment with streptocycline @ 250 ppm followed by two foliar sprays of streptocycline @ 250 ppm or 1st foliar spray of copper oxychloride @ 0.3 per cent and 2nd foliar spray of streptocycline @ 250 ppm at 15 days interval was found the most effective in reducing the per cent disease severity and increasing the grain and fodder yield in clusterbean.

Conflict of interest: None.

REFERENCES

Amin, A.M., Patel, N.R., Jaiman, R.K., Prajapati, D.B. and Amin, A.U. (2017). Management of bacterial blight in clusterbean. Environ. Ecol. 35(2C): 1223-1227.

Anonymous. (2020). Directorate of Economics and Statistics, Government of Rajasthan, Jaipur.

Antre, S.H., Gadhe, S.K., Abhang, P.B. and Autade, R.H. (2016). *In vitro* efficacy of different chemicals, botanicals and bioagent against *Xanthomonas axonopodis* pv. *punicae*. Int. J. Pure App. Biosci. 4(3): 112-118.

Bagri, R.K., Goyal, S.K. and Shekhawat, S.S. (2019). Management of bacterial leaf disease of clusterbean in semi arid tropic of Rajasthan. Pl. Dis. Res. 34(1): 58-60.

Bala, A., Rai, B., Priya, S. and Kumar, R. (2017). *In vitro* evaluation of various fungicides and plant extracts against *Xanthomonas oryazae* pv. *oryzae.* Isolated from rice (*Oryza sativa* L.). Int. J. Curr. Microbiol. App. Sci. 6(5): 421-427.

Gupta, D.K. (1991). Studies on black rot of cabbage in Manipur. J. Mycol. Pl. Pathol. 21: 203-204.

Jagtap, G.P., Jangam, A.M. and Dey, U. (2012). Management of bacterial blight of cotton caused by *Xanthomonas axonopodis* pv. *malvacearum*. Sci. J. Microbiol. 1(1): 10-18.

Jambenal, S., Ravikumar, M.R. and Hiremani, N. (2011). Basic sudy on *Xanthomonas campestris* pv. *viticola* causing bacterial leaf spot of grape and evaluated *in vitro* efficacy of different chemicals and bioagents against its growth. Int. J. Pl. Prot. 4(2): 397-401.

Kumar, D. (2005). Status and direction of arid legumes research in India. Ind. J. Agric. Sci. 75(7): 375-391.

Kumar, D. and Rodge, A.B. (2012). Status, scope and strategies of arid legumes research in India- A review. J. Food Leg. 25(4): 255-272.

Kumar, L. and Jahagirdar, S. (2017). *In vitro* evaluation of antibiotics, chemicals and bioagents against *Xanthomons axonopodis* pv. *glycines.* Pl. Arch. 17(1): 742-744.

Kumar, R., Jahagirdar, M.R.S., Yenjerappa, S.T. and Patil, H.B. (2009). Epidemiology and management of bacterial blight of pomegranate caused by *Xanthomonas axonopodis* pv. *punicae*. Acta Hortic. 818(4): 291-296.

Kumhar, D.R., Meena, A.K. and Meena, P.N. (2018). Efficacy of different management modules against bacterial blight of clusterbean under epiphytotic conditions. J. Pharmacogn. Phytochem. 7(3): 1505-1509.

Lokesh, R., Erayya, Kumaranag, K.M., Chandrashekar, N. and Khan, A.N.A. (2014). *In vivo* efficacy of some antibiotics against bacterial blight of pomegranate caused by *Xanthomonas axonopodis* pv. punicae, Int. Res. J. Biol. Sci. 3(1): 31-35.

Madavi, P.N., Totawar, M.V. and Mane, S.S. (2020). *In vitro* efficacy of antibiotics amongst the Isolates of *Xanthomonas axonopodis* pv. citri. Int. J. Curr. Microbiol. App. Sci. 9(8): 3494-3505.

Prasad, D., Singh, R. and Deep, S. (2018). *In vitro* and *in vivo* efficacy of antibacterial compounds against *Xanthomonas oryzae* pv. *oryzae* a cause of bacterial leaf blight of rice. Int. J.Curr. Microbiol. App. Sci. 7(5): 2960-2969.

Rathore, B.S. (2006). Efficacy of streptocycline and plant extracts against bacterial leaf spot disease caused by *Xanthomonas axonopodis* pv. *vignaradiatae* of green gram. Ind. Phytopathol. 63(4): 384-386.

Thammaiah, N. and Khan, A.N.A. (1995). Effect of seed treatment on *Xanthomonas campestris* pv. *vignicola* causal agent of bacterial blight of cowpea. Adv. Agric. Res. Ind. 4: 93-102.

Yenjerappa, S.T., Kumar, M.R., Jawadagi, R.S. and Khan, N.A. (2004). *In vitro* and *in vivo* Efficacy of Bactericides against Bacterial Blight of Pomegranate. Paper presented In: National Symposium on Crop Surveillance: Disease Forecasting and Management, IARI, New Delhi (India), pp. 84.

Yenjerappa, S.T., Rafee, C.M. and Nargund, V.B. (2011). Field performance of bactericides, bioagents and botanicals against bacterial blight of pomegranate. Acta Hortic. 89: 529-531.