Int.J.Curr.Microbiol.App.Sci (2018) *7*(7): 3011-3022

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 07 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.707.352

Botanical Based Protection could be a Sustainable Alternative in Management of Castor (*Ricinus communis*) Wilt Caused by *Fusarium oxysporum* f.sp. *ricini*

Shalini Yerukala[1*], Vidya Sagar Bokka[1] and Giribabu Palaniappan[2]

[1]*Professor Jayashankar Telangana State Agricultural University, Department of Plant Pathology, College of Agriculture, Rajendranagar Hyderabad-30, India*
[2]*Directorate of Oilseeds Research, Rajendranagar, Hyderabad-30 Telangana, India*
**Corresponding author*

Keywords

Castor, *Fusarium oxysporum* f.sp. *ricini*, Botanicals, Inhibition

Article Info

Accepted:
24 June 2018
Available Online:
10 July 2018

A B S T R A C T

Castor (*Ricinus communis* L.) experienced serious declines in yield caused by wilt pathogen *Fusarium oxysporum* f.sp. *ricini.* To control the wilt pathogen, commonly fungicides are used, which cause undesirable toxic effect on the environment. To minimize the pollution impact, there is an urgent need to develop alternative ecofriendly strategies. Therefore, to fill these knowledge gaps and to investigate potential botanical's efficacy on the wilt pathogen *F. oxysporum* f.sp. *ricini*, an *in vitro* bioassay was conducted. Twenty-six botanicals were extracted at two different concentrations *viz.* 5 percent and 10 percent and were evaluated against the castor wilt pathogen, using poisoned food technique in terms of percent inhibition. The botanical henna showed significant (93.88 percent) inhibition of pathogen at 10 percent concentration, followed by neem cake (89.90 percent), ashoka (88.05 percent) and aloe (87.68 percent). Whereas at 5 percent concentration, botanical neem cake showed maximum inhibition (88.42 percent) followed by aloe (85.46 percent) and henna (83.70 percent). The plant extracts neem cake, aloe and henna significantly inhibited the pathogen growth at both the concentrations, indicating botanicals as potential future bio-fungicides. However, still further research needed to better understand the mechanisms underlining pathogen inhibition by plant extracts. Hence, the current study put forth that botanical based protection could be a potential alternative for the sustainable management of *F. oxysporum* f.sp. *ricini.*

Introduction

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop. India ranks first in both area (10.96 lakh ha) and production (11.43 lakh tonnes) of castor in the world (Indiastat, 2013). In India Gujarat, Rajasthan and erstwhile Andhra Pradesh are the major castor producing states. However, in the past decade, the castor has been severely affected by wilt pathogen causing yield loss up to 85 percent depending on fungal inoculum level and environmental conditions (Dange, 2003). The castor wilt causal agent *F. oxysporum* f.sp. *ricini* is both soil and seed borne pathogen, colonize xylem vessels of host plant, and causing immense yield loses. In erstwhile Andhra Pradesh, wilt incidence

ranged from 5-60 percent, causing yield reduction of 1.86 kg/ha with each percent incidence of wilt disease (Chattopadhyay, 2000). Generally, fungicides are used against phytopathogenic fungi to control the plant diseases. But the continuous use of chemical fungicides in the management of plant disease impose harmful side effects on environment and has become a major threat to mankind. Hence, in recent years there has been increased awareness on toxic hazards of chemicals to crops, consumer and environment due to residual phytotoxicity and pollution effect. Developing eco-friendly and economical based protection to control plant diseases could be another best source (Yerukala *et al*., 2017; Yerukala *et al*., 2018). Include screening of plant products for their effective antifungal activity against the plant pathogens, could be another alternative to minimize the fungicide usage. Many studies have already been documented showing the botanicals fungitoxic nature and ability to inhibit the phytopathogen growth.

Studies include leaf extracts of neem and chinaberry inhibited wilt disease of tomato caused by *F. oxysporum* f.sp. *lycopersici* (Hassanein *et al.,* 2008), others such as botanicals datura and isabgul inhibited *F. oxysporum* f.sp. *cumini* growth (Bhatnagar *et al.,* 2004). Plant extracts of garlic, turmeric and black pepper reduced *F. udum* and *F. oxysporum* f.sp. *ciceri* growth (Shukla and Dwivedi, 2012). Additionally, floral extracts of *Lantana camera* inhibited spore germination and germ tube growth of *Alternaria solani in vitro* (Sundriyal, 1997). Despite many studies, there exits some research gap with respect to the plant extracts effect against *F. oxysporum* f.sp. *ricini*. Therefore, in present investigation, different plant species were evaluated for the possible presence of fungi toxic nature and efficacy against the mycelial growth of *F. oxysporum* f.sp. *ricini in vitro*. We aimed to address the following issues: 1) Find out the best botanical effective against the *F. oxysporum* f.sp. *ricini* among tested plant species for management of castor wilt 2) Plant part of the botanical that could be used effective against wilt pathogen growth reduction. 3. Suggestion or identification of botanicals, that could be economical for the farmers to manage the castor wilt disease.

Materials and Methods

All the experiments were carried out at Department of Plant Pathology, College of Agriculture, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, India. Twenty-six botanicals (Table 1, Fig. 2) were procured and their extracts were prepared by methodology mentioned by Mahapatra and Das, 2013. Efficacy of these plant extracts (Fig 3) against *F. oxysporum* f.sp. *ricini* (Fig. 1.) was evaluated under *in vitro* condition by using poisoned food technique (Kumar and Devendra, 2013). Percent inhibition over control was calculated using the formula mentioned below (Shalini *et al.,* 2014).

$$R = (X - Y) / X \times 100$$

Where, R = Per cent growth reduction of test pathogen,

X = Radial growth of test pathogen in control (mm)

Y = Radial growth of test pathogen in treatment (mm)

The data obtained was transformed using angular transformations (Panse and Sukhatme, 1978) and was statistically analyzed using CRD (Completely Randomized Design), as per procedures suggested by Snedecor and Cochran, 1967). Both actual percentage values and their corresponding transformed values have been presented in Table 1.

Results and Discussion

All the plant species studied showed inhibition of *F. oxysporum* f.sp. *ricini* growth at different magnitude and the results are presented in Table 1 and figure 4, 5 and 6. At 5 percent concentration, neem cake showed maximum inhibition (88.42 percent). Other plant extracts at 5 percent which showed percent inhibition above 80 were aloe (85.46 percent), henna (83.70 percent), black pepper (82.96 percent) and tulsi (80.83 percent) (Fig. 4). At 10 percent concentration, henna was found superior with 93.88 percent inhibition. Other plant extracts at 10 percent which showed significant inhibition were neem cake (89.90 percent), ashoka (88.05 percent), aloe (87.68 percent), tulsi (85.83 percent), eucalyptus bark (85.74 percent), neem bark (85.55 percent), black pepper (83.79 percent), mint (82.31 percent), pongamia (81.57 percent) and calotropis leaf (81.01 percent) (Fig. 5). In the present study, all the plant extracts showed considerable growth reduction of *F. oxysporum* f.sp. *ricini* compared to control, however neem cake at both the concentrations performed better over other botanicals tested, and furthermore other best two botanicals include henna and aloe, while least inhibition of pathogen growth was recorded by lime. The results are in accordance with Joseph *et al.* 2008 who found that, neem extract effectively inhibited *F. solani* f.sp. *melongenae* growth at 5, 10, 15 and 20 percent *in vitro*. Similarly, Chavan and Hegde, 2009 reported that neem seed kernel extract reduced the *F. solani* growth by 74.86 percent. The superiority of neem extract on inhibition of fungal pathogen was also mentioned by Sharma *et al.* 2011 on *F. oxysporum* f.sp. *lycopersici* in tomato. Similar results on neem effects were noted by Asit *et al.*, 2010 on *Alternaria* blight in malabar nut; *Alternaria alternata* in *Vicia faba* (Kumar *et al.*, 2005); on *F. pallidoroseum* and *F. oxysporum* (Gupta *et al.*, 1996). The fungitoxic property of neem could mainly attributed by the presence of various compounds includes azadirachtin, meliantriol, nimbin, nimbidin, 3-deacetylsalannin, salannol, salannin, 1,3 diacetylvilasinin, diacetylvilasinin, nimbandiol, azadirone, azadiradion, gedunin, nimbinene, nimocinolide, isonimocinolide, and isonimbocinolide, and trisulfides and tetrasulfides etc. (Koul *et al.*, 1990; Biswas *et al.*, 2002). Especially neem cake contains salannin, nimbin, azadirachtin and azadiradione as the major components (Del Serrone and Nicoletti, 2013) these phytochemicals could be possible niche for inhibition of the wilt pathogen growth (*F. oxysporum* f.sp. *ricini*). In addition, neem cake is a waste byproduct of neem oil extraction processes, used mainly as organic manure (Bureau of Indian Standards, Specification No. 8558). Moreover, neem cake, due to its lower cost in market and availability, farmers could procure easily and sustainably manage the wilt disease in castor.

In the study, apart from plant extract neem cake, henna and aloe also significantly inhibited wilt pathogen growth at both the concentration, suggesting its potentiality of botanical based eco-fungicide nature to manage the castor wilt. The fungitoxic nature of henna leaves against wilt pathogen could be possibly due to the presence of different chemical compounds such as hennatannic acid, lawsone, 2-hydroxy-1:4 napthaquinone, lawsone, gallic acid, glucose, mannitol, fats, resin, mucilage, other phytochemicals such as luteolin-7-o-glycoside, luteolin-3'-o-glycoside, stigmasterol, cosmosiin (acacetin-7-o-glucoside), acacetin, p-coumaric acid, fraxetin, scopoletin, esculetin, 1,2-dihydroxy-4-o-glucosyloxy naphthalene, lawsoniaside, lalioside, 2-methoxy-3-methyl-1, 4-napthoquinone, apiin, apigenin, lupeol, betulin and betulinic acid (Chaudhary *et al.*, 2010). In addition, botanical aloe also showed significant reduction of *F. oxysporium*

f.sp. *ricini* growth on par with henna, the fungi toxic nature of aloe could be due to the phytochemical compounds presence, include aloin, barbaloin, 10-(1',5'-anhydroglucosyl)-aloe-emodin-9-anthrone, aloe-emodin (Shelton, 1991).

Table.1 *In vitro* efficacy of different plant extracts against *F. oxysporum* f.sp. *ricini*

Botanicals	Botanical name	Family	Plant part used	*Radial growth of *F. oxysporum* f.sp. *ricini* (mm)	*Per cent inhibition over control	*Radial growth of *F. oxysporum* f.sp. *ricini* (mm)	*Per cent inhibition over control
				5%		**10%**	
Garlic	*Allium sativum L.*	Liliaceae	Clove	34.75	61.38 (51.56)	31.91	64.53 (53.45)
Neem	*Azardirachta indica A.*	Meliaceae	Leaf	25.16	72.03 (58.10)	19.91	77.87 (61.94)
Onion	*Allium cepa L.*	Liliaceae	Bulb	34.08	62.12 (52.00)	31.91	64.53 (53.45)
Ginger	*Zingiber officinale*	Zingiberaceae	Rhizome	48.66	45.92 (42.64)	45.50	49.44 (44.66)
Tulsi	*Ocimum sanctum L.*	Labiateceae	Leaf	17.25	80.83 (64.01)	12.75	85.83 (67.86)
Pongamia	*Pongamia pinnata L.*	Fabaceae	Leaf	24.25	73.05 (58.71)	16.58	81.57 (64.55)
Custard Apple	*Annona squamosa*	Annonaceae	Leaf	52.66	41.48 (40.06)	30.75	65.83 (54.21)
Lime	*Citrus sinensis*	Rutaceae	Leaf	69.66	22.59 (28.34)	45.83	49.07 (44.45)
Mint-weed	*Lantana camara*	Verbenaceae	Leaf	41.16	54.25 (47.58)	34.83	61.29 (52.35)
Chili	*Capsicum annum*	Solanaceae	Fruit (pod)	50.50	43.88 (41.44)	36.66	59.25 (51.35)
Ashoka	*Polyalthia longifolia*	Fabaceae	Leaf	20.75	76.94 (61.31)	10.75	88.05 (69.78)
Lantana	*Hyptis suaveolens*	Lamiaceae	Leaf	27.50	69.44 (56.43)	24.91	72.31 (58.30)
Mint	*Mentha Arvensis*	Lamiaceae	Leaf	29.75	66.94 (54.92)	15.91	82.31 (65.38)
Parthenium	*Parthenium hysterophorous*	Asteraceae	Leaf	26.41	70.64 (57.22)	20.00	77.77 (62.21)
Calotrope	*Calotropis gigantean*	Apocynaceae	Leaf	26.50	70.55 (57.11)	17.08	81.01 (64.46)
Calotrope	*Calotropis gigantean*	Apocynaceae	Flower	22.83	74.62 (59.75)	21.00	76.66 (61.53)
Tuja	*Thuja occidentalis*	Cupressaceae	Leaf	25.66	71.48 (57.70)	23.08	74.35 (59.57)
Lantana bark	*Lantana camara*	Verbenaceae	Stem	25.91	71.20 (57.55)	25.75	71.38 (57.64)
Neem bark	*Azardirachta indica A.*	Meliaceae	Bark	22.16	75.37 (60.35)	13.00	85.55 (68.45)
Eucalyptus bark	*Eucalyptus citridora*	Myrtaceae	Bark	21.16	76.48 (61.31)	12.83	85.74 (67.82)
Ashoka bark	*Polyalthia longifolia*	Annonaceae	Bark	25.66	71.48 (57.70)	23.83	73.51 (59.01)
Henna tree	*Lawsonia inermis*	Lythraceae	Leaf Powder	14.66	83.70 (66.17)	5.50	93.88 (75.67)
Turmeric	*Curcuma longa*	Zingiberaceae	Powder	28.75	68.05 (55.56)	21.91	75.64 (60.43)
Aloe vera	*Alo vera*	Liliaceae	Leaf	13.08	85.46 (67.57)	11.08	87.68 (69.43)
Neem cake	*Azardirachta indica A.*	Meliaceae	Cake	10.41	88.42 (70.08)	9.08	89.90 (71.45)
Piper nigrum	*Piper nigrum*	Piperaceae	Dried Unripe Fruit	15.33	82.96 (65.59)	14.58	83.79 (66.24)
Control				90.00	0.00 (4.05)	90.00	0.00 (4.05)
Mean				65.23		72.5	
CD at 5%				4.98		8.89	
S.Ed±				2.48		4.42	
S.Em±				1.75		3.12	

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

Fig.1 Pure culture of *Fusarium oxysporum* f.sp. *ricini*

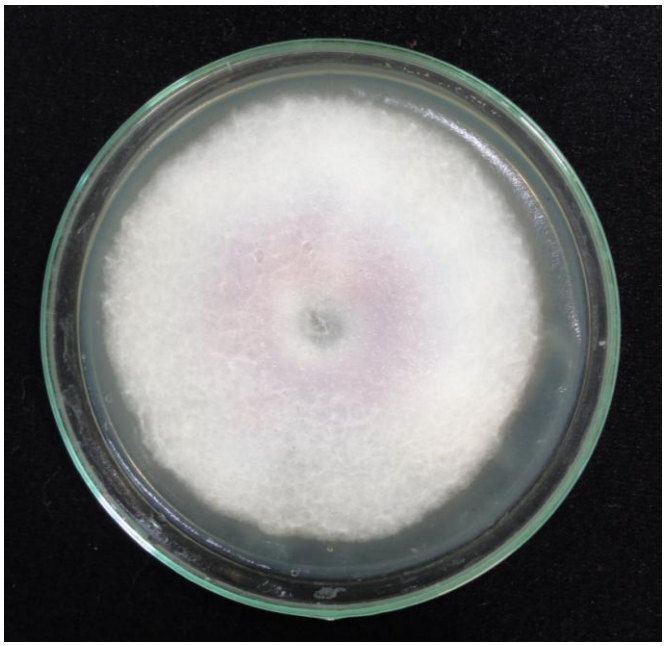


Fig.2 Botanicals used in the *in vitro* study against castor wilt pathogen

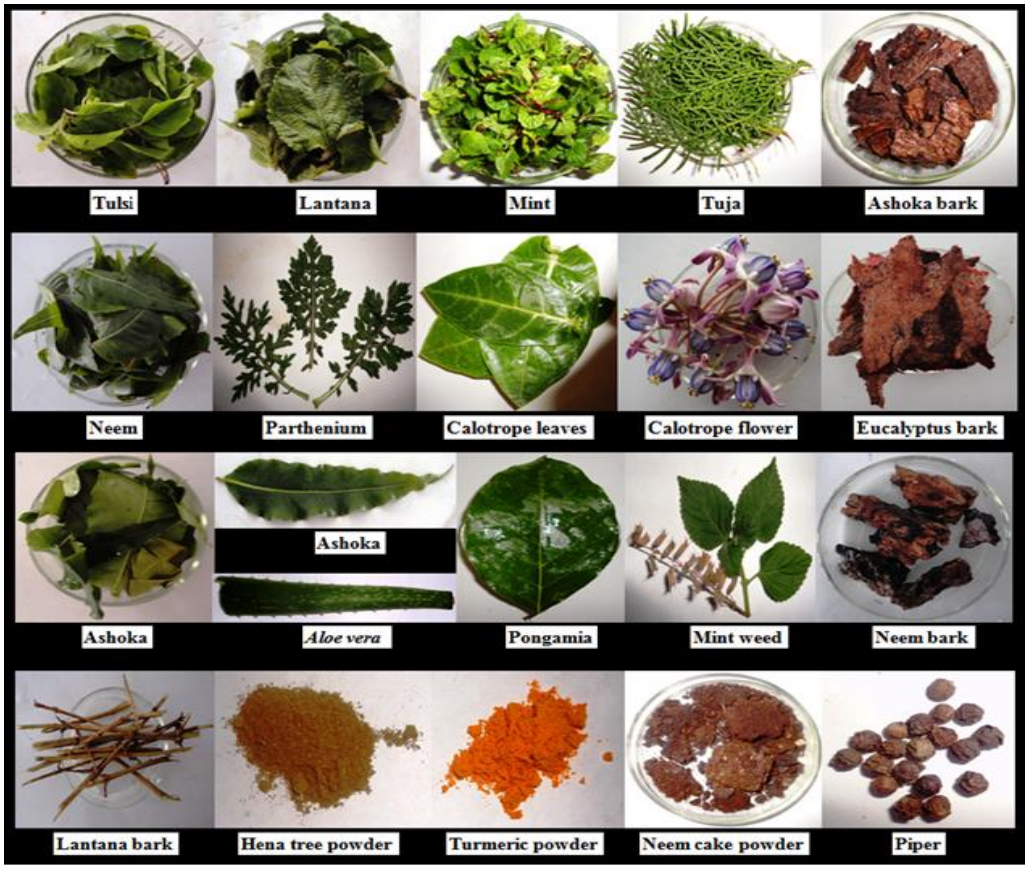


Fig.3 Plant extracts prepared for the study

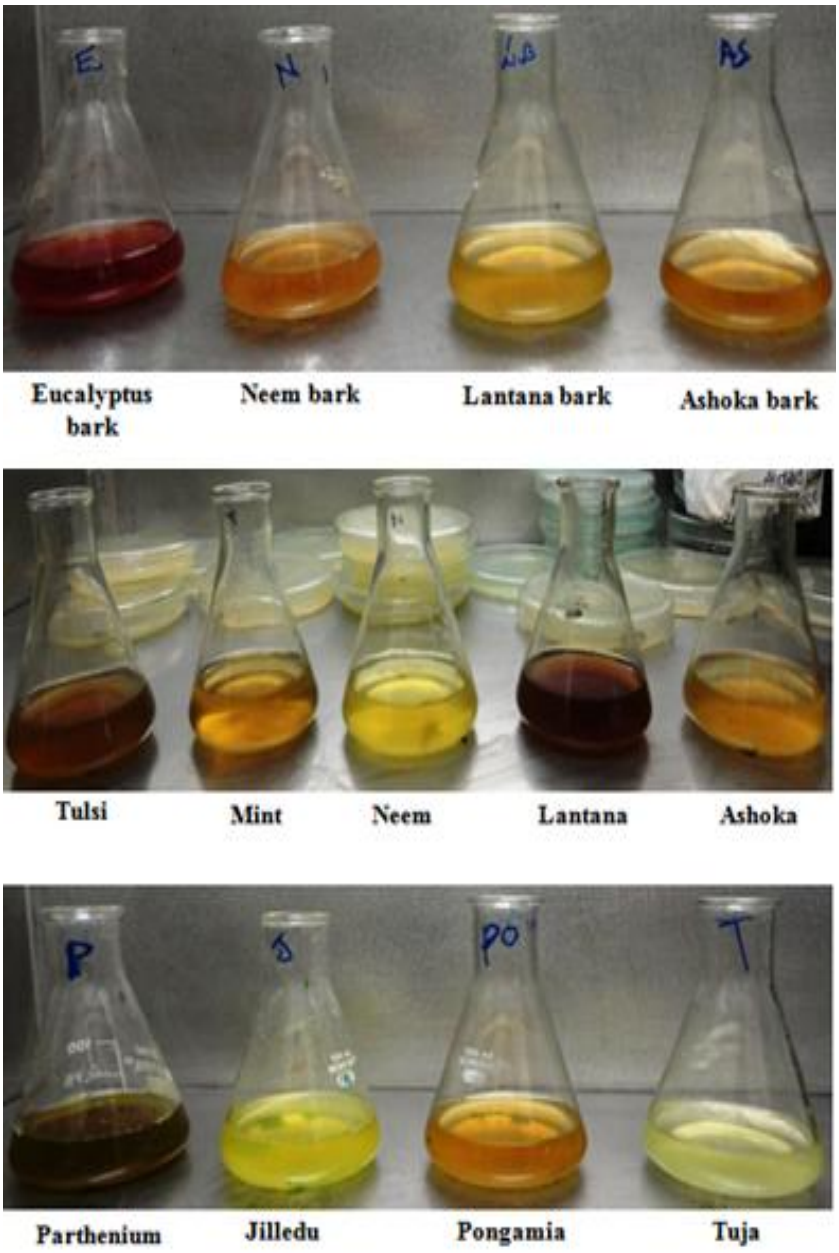
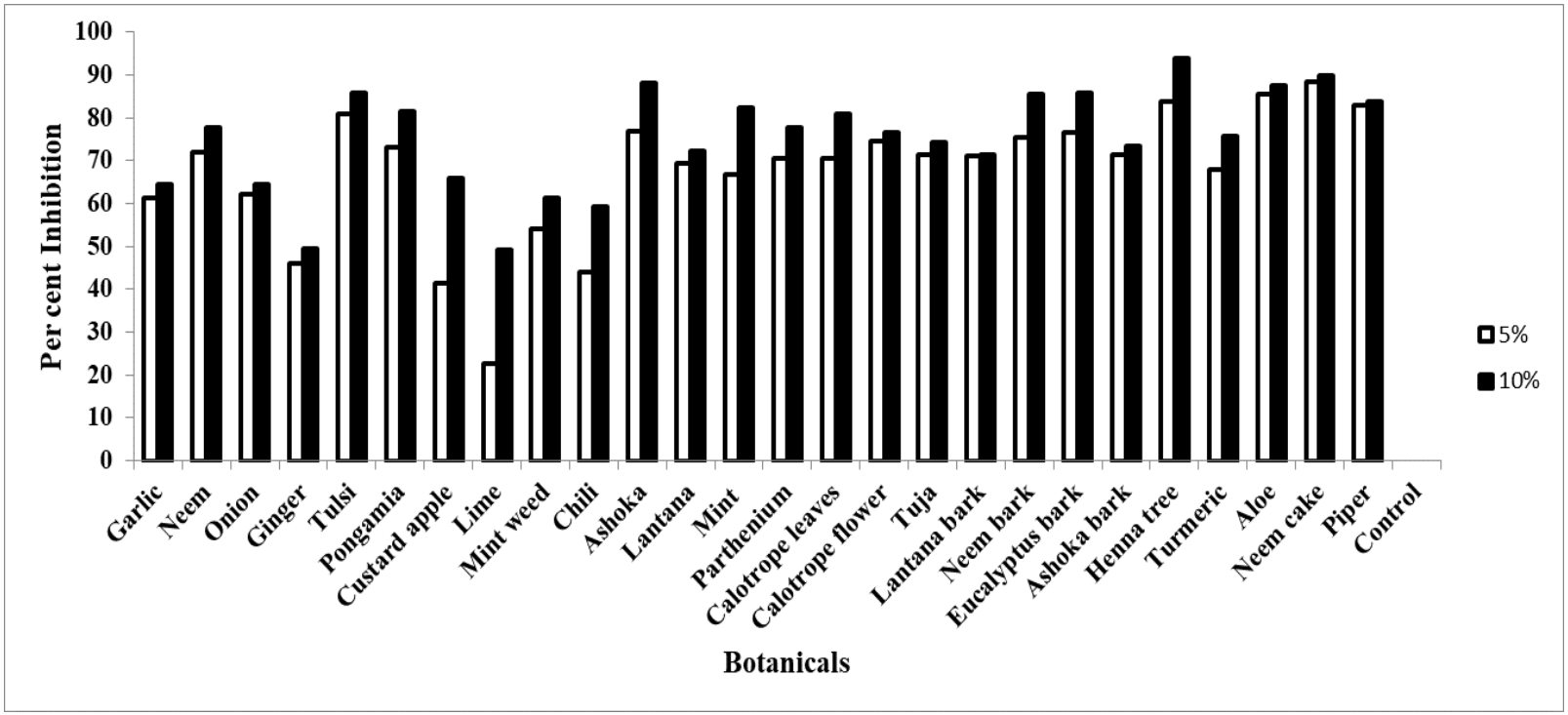


Fig.4 *In vitro* evaluation of plant extracts at 5 % concentration against *F. oxysporum* f.sp. *ricini*

Fig.5 *In vitro* evaluation of plant extracts at 10% concentration against *F. oxysporum* f.sp. *ricini*

Fig.6 Effect of plant extracts on the radial growth of *F. oxysporum* f.sp. *ricini*



In current study, a bunch of botanicals which possess fungitoxic properties against *F. oxysporum* f.sp. *ricini* has been discovered, include neem cake, henna, aloe, ashoka, tulsi, eucalputus bark, neem bark, others presented in Table 1. Moreover, plant extracts have equal potential as fungicides for the reduction of pathogen growth, as observed in the results. The results are in accordance with Irum, 2007, who reported antifungal effect of aqueous extracts of four plant species viz., *Azadirachta indica, A. Juss., Datura. metel* L., *Ocimum sanctum L.* and *Parthenium hysterophorus* L., found that all the four plant extracts tested at 40 percent concentration effectively reduced the mycelial growth of *F. oxysporum* f.sp. *ciceri*.

Moreover, interesting fast noted in the study was, concentration of plant extracts used is directly proportional to the inhibition of pathogen growth, implies higher the concentration of botanical, higher the pathogen growth inhibition. Additionally, in twenty-six botanicals used, the plant parts found to be having promising fungitoxicity against wilt pathogen include neem cake powder, leaves (henna, ashoka, tulsi, mint, calotropis), bark (neem and eucalyptus) and dried fruit (black pepper) etc.

In conclusion, our investigation put forth, that neem cake, henna leaves and aloe are the best botanicals among others tested plant species in inhibition of *F. oxysporum* f.sp. *ricini* growth. In the plant species tested, the plant parts that could be effective in inhibition of castor wilt pathogen mostly include leaves, bark etc. Also, the above tested best three botanicals neem cake, henna and aloe could be easily procured by the farmers from the local market and could be used for the management of the castor wilt disease at lower cost. Furthermore, season long market availability of these three botanicals, provide easy access and would be economical for the farmers. Additionally, botanical based protection is ecofriendly and sustainable. However, still further research need to be done to better understand the tested botanicals mechanisms against the wilt pathogen; Future line of research may include efficacy of these botanicals at glass-house and field conditions; Isolation and identification of individual compounds from the plant crude extracts and mode of action against the castor wilt pathogen.

Acknowledgements

The authors are grateful to the College of Agriculture, Rajendranagar, Hyderabad, India for providing the financial assistance and support for conducting this research.

References

Asit, D., Tripathi, M. K., and Versha, M. 2010. Evaluation of fungicides and plant extracts for Alternaria blight management in Malabar nut (Adhatoda vasica). *Annals of Plant Protection Sciences*, 18(1), 256-258. *https://www.cabdirect.org/cabdirect/abstract/20103164596*

Bhatnagar, K., Sharma, B. S. and Cheema, H. S. 2004. Efficacy of plant extracts against F. *oxysporum* f. sp.*cumini* causing wilt in cumin, *Journal of Mycology and Plant Pathology*. 34(2): 360-361.

Biswas, K., Chattopadhyay, I., Banerjee, R. K., and Bandyopadhyay, U. 2002. Biological activities and medicinal properties of neem (*Azadirachta indica*). *Current Science-Bangalore*, 82(11), 1336-1345. *http://repository.ias.ac.in/5193/1/305.pdf*

Chattopadhyay, C. 2000. Seed borne nature of *F. oxysporum* f. sp. *ricini* and relationship of castor wilt incidence

with seed yield, *Journal of Mycology and Plant Pathology*. 30: 265.

Chaudhary, G., Goyal, S. and Poonia, P. 2010. *Lawsonia inermis* Linnaeus: a phytopharmacological review, *Int J Pharm Sci Drug Res*. 2(2): 91-8. *https://goo.gl/urRdtK*

Chavan, S. S., and Hegde, Y. R. 2009. *In vitro* biological management of *Fusarium* wilt of patchouli caused by *Fusarium solani*. *International Journal of Plant Protection*, 2(1), 123-125. *https://www.cabdirect.org/cabdirect/abstract/20093334068*

Dange, S. R. S. 2003. Wilt of Castor - An overview, *Indian Journal of Mycology and Plant Pathology*. 33(3): 333-339.

Del Serrone, P., and Nicoletti, M. 2013. Antimicrobial activity of a neem cake extract in a broth model meat system. *International journal of environmental research and public health*, 10(8), 3282-3295.

Gupta, V. P., Datta, G., and Datta, R. K. 1996. Plant extracts: A non-chemical approach to control *Fusarium* diseases of mulberry. *Current Science*, 406-409. *https://goo.gl/j19tb1*

Hassanein, N. M, Abou Zeid, M. A, Youssef, K. A. and Mahmoud, D. A. 2008. Efficacy of leaf extracts of neem (*A. indica*) and chinaberry (*Melia azadrach*) against early blight and wilt diseases of tomato, *Australian Journal Basic Applied Sciences*. 2(3): 763-772. *http://ajbasweb.com/old/ajbas/2008/763-772.pdf*

Indiastat., Crop statistics in India. *www.indiastat.com/*. 2013.

Irum, M. 2007. Comparison of phytochemical and chemical control of *Fusarium oxysporum* f. sp. *cicera*. *Mycopathologia*, *5*(2), 107-110. *https://goo.gl/d8MurP*

Koul, O., Isman, M. B., and Ketkar, C. M. 1990. Properties and uses of neem, *Azadirachta indica*. *Canadian Journal of Botany*, *68*(1), 1-11.

Kumar, S., Upadhyay, J. P., and Kumar, S. 2005. Evaluation of plant extracts for control of Alternaria leaf spot of *Vicia faba*. *Annals of Plant Protection Sciences*, 13(1), 258-259. *https://goo.gl/qGbgpj*

Kumar, V., and Devendra, T. 2013. Antifungal activity evaluation of different extracts of *Bergenia stracheyi*, *International Journal of Current Microbiology and Applied Sciences*. 2(7): 69-78. *https://goo.gl/LpJPL3*

Mahapatra, S., and Das, S. 2013. Bioefficacy of botanicals against *Alternaria* leaf blight of mustard under field condition. *The Bioscan*, 8(2), 675-679. *https://goo.gl/CM2sEo*

Panse, V.G. and Sukhatme, P.V.1978. Statistical methods for agricultural workers, *Indian Agriculture Research Institute*, New Delhi. 361.. *https://goo.gl/ezTYjL*

Shalini, Y., Sagar, B. V., Giribabu, P., and Rao, V. K. 2014. Management of wilt disease complex in castor. *Indian Journal of Plant Protection*, 42(3), 255-258. *https://goo.gl/fvj491*

Sharma, B. K., Singh, R. P., Loganathan, M., Mishra, P. K., Rai, R. K., Saha, S. and Rai, A. B. 2011. *In vitro* efficacy of some botanicals against *F. oxysporum* f. sp. *lycopersici* causing wilt in tomato, *Journal of Interacademicia*. 15 (1): 1-5.

Shelton, R. M., Aloe vera. 1991. Its Chemical and Therapeutic Properties. *International journal of dermatology*. 30(10): 679-683. *https://doi.org/10.1111/j.1365-4362.1991.tb02607.x*

Shukla, A., and Dwivedi, S. K. 2012. Bio efficacy of plant extracts against *Fusarium* species causing wilt in

pulses. IOSR *Journal of Engineering*, Índia, 2(1), 136-144. *https://goo.gl/7ntoJ7*

Snedecor, G.W., and Cochran, W.G. 1967. Statistical methods. *Oxford and IBH Publishing Company*, New Delhi. 593:151-156. *https://goo.gl/Zxk5BM*

Sundriyal, R. C. 1997. Fungitoxic properties of flower extracts of some wild plants of Garhwal Himalaya, *Advances in Plant Sciences.* 4 (2): 230-234. *https://goo.gl/5UiC4g*

Yerukala, S., and Bokka, V. S. 2018. Screening Antimicrobial Potential of Copper Nanoparticles against *Pseudomonas fluorescens* and *Bacillus subtilis* and Its Sustainability in Agriculture. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 1606-1617.doi: *https://doi.org/10.20546/ijcmas.2018.706.xx; https://goo.gl/zs7S4t*; *https://goo.gl/r9TeRD*

Yerukala, S., Bokka, V. S., Palaniappan, G., and Rao, V. K. 2017. Efficacy of Fungal Versus Bacterial Bioagents on *Fusarium* Wilt of Castor. *Int. J. Curr. Microbiol. App. Sci*, *6*(11), 1230-1239. *https://doi.org/10.20546/ijcmas.2017.611.146*

How to cite this article:

Shalini Yerukala, Vidya Sagar Bokka and Giribabu Palaniappan. 2018. Botanical Based Protection could be a Sustainable Alternative in Management of Castor (*Ricinus communis*) wilt Caused by *Fusarium oxysporum* f.sp. *ricini*. *Int.J.Curr.Microbiol.App.Sci.* 7(07): 3011-3022. doi: https://doi.org/10.20546/ijcmas.2018.707.352