Research Journal of Agriculture and Forestry Sciences _____ISSN 2320 – 6063
Vol. **5(10),** 1-6, October **(2017)** *Res. J. Agriculture and Forestry Sci.*

The efficacy of botanical pesticides for managing powdery mildew, *Oidium anacardii* Noack disease in cashew, *Anacardium occidentale* L. plantations in Tanzania

Nene W.A.*, Shomari S.H. and B.B. Assenga
Naliendele Agricultural Research Institute, P.O. Box 509, Mtwara, Tanzania
wilsoninene@gmail.com

Available online at: www.isca.in
Received 24th August 2017, revised 1st October 2017, accepted 8th October 2017

Abstract

Powdery Mildew Disease (PMD), which is caused by fungus Oidium anacardii is a serious devastating disease to cashew (Anacardium occidentale L.), can cause significant losses in both yields and quality if not controlled. Extracts from plants play a significant role in crop protection strategies. We conducted field experiments in 2014 and 2015 cashew seasons to test botanicals' efficacy against cashew PMD in Tanzania. Five plants were used, namely; Opuntia ficus-indica, Opuntia vulgalis, Euphobia tirucalli, Azadirachta indica and Bobgunnia madagascariensis. Tridimenol (250 EC), a synthetic fungicide was used as control standard. A Randomized Complete Block Design was used with four replications. A net plot consists of two cashew trees and ten panicles from each cashew tree were selected and used as experimental unit. Knapsack hand sprayer was used for fungicides applications, and spraying was done in a fortnight's interval. The results indicate that, cashew trees treated with extracts from O. ficus-indica consistently recorded lower (between 16 and 32%) PMD infection compared to other botanicals (32 and 58%). Cashew trees treated with Triadimenol 250 EC, a synthetic fungicides recorded<7% PMD infection. However, due to negative environmental effects posed by these synthetic pesticides, plant extracts from O. ficus-indica can be a potential candidate to smallholder farmers for cashew protection against fungal disease caused by Oidium anacardii. Further studies are recommended to identify chemical compounds present in these plants and testing different methods of extraction. Correspondingly, other solvents can be used for further investigation of microbial activity from these botanicals.

Keywords: Cashew, Plant extracts, Crop protection, Disease, Tanzania.

Introduction

Cashew (*Anacardium occidentale* Linn) is one of the most important commercial crops in many tropical countries including Tanzania[1-4]. In Tanzania, cashew is an important cash crop to the national economy which contributed to 18 percent of Tanzania's merchandise export earnings in 1999[5]. Cashew industry in Tanzania contributes 5 percent of the country's export earnings which are estimated at US$70 million annually[1].

Despite its importance, cashew production in Tanzania is constrained by several factors that often result to yield loses. The fungal pathogen (*Oidium anacardii*), which causes Powdery Mildew Disease (PMD) is cited as the leading biotic factor which causes substantial yield losses[6-8].

The pathogen penetrates vascular tissues of the host tree and blocks the movement of nutrients and water from the root to the remaining parts of the tree[9]. The main loss of cashew productivity is caused by the infection on the young flower buds and flowers[3]. Studies have shown that, the disease can cause between 70 and 100% reduction in nut yields if not controlled. High mildew epidemic levels are normally between July and August, which is the flowering and fruiting stages of the crop[9].

Naliendele Agricultural Research Institute (NARI) has recommended several synthetic fungicides with more active ingredients (a.i.) of Triadimenol, Hexaconazole, and Penconazole among others, in the control PMD. Thus, majority of cashew growers in Tanzania use synthetic fungicides in the control of PMD[9,10].

However, the use of synthetic pesticides has negative consequences to public health and to the environment[11-13]. Therefore in different countries in the world, research efforts in developing alternative control strategies, including the use of bio-pesticides such as extracts from plants, has been in the increase[14]. The use of bio-pesticides is further triggered by the emergence of markets for organic produce in the tropical countries[15].

Extracts from plants play an important role in crop protection strategies[16]. Plant extracts inhibit spore germination[17] and mycelia growth in several fungal species[18-20]. The bio-pesticides from plants are natural pesticides which are less toxic, thus have less negative effects to birds, and they are beneficial to insects and mammals as compared to conventional pesticides[21]. Furthermore, bio-pesticides from plants are considered as cheap, environmentally friendly, and sustainable solutions for crop

protection[14]. Therefore, botanical pesticides, if applied, can be a better alternative in the management of PMD caused by *O. anacardii* in the cashew crop.

The use of extracts from plants in the management of PMD caused by a fungus, *O.anacardii* in cashew is not well known. However, extracts from different plant types and parts have been applied in other crops in the protection against fungal diseases[22]. For instance, Allicin from garlic has been used in the management of Phytophthora leaf blight of tomato, tuber blight of potato, downy mildew of *Arabidopsis thaliana* and in the control of carrot seed-borne *Alternaria*spp[23].

The extracts from parts of neem (*Azadirachta indica)* tree contain antifungal and antibacterial properties[24]. The use of commercial formulations of neem namely; neemgold and neemazil effectively control the stem rot disease caused by *Rhizoctonia solani* Khn[25]. Extracts from the leaf part of neem inhibited fungal growth in brinjal seeds, *Solanum melongena* L[26]. Bio-pesticides from some plants can similarly be more effective than chemical fungicide in reducing root rot incidences[27]. Therefore, the aim of this study was to test the efficacy of extracts from the selected plants in managing PMD caused by *O. anacardii* in cashew crop under a unimodal pattern in Tanzania.

Materials and methods

Description of the study area: Studies were conducted between July and September of 2014 and 2015 at Naliendele Agricultural Research Institutein Mtwara region and Mkumba-Nachingwea in Lindi region to test the efficacy of selected botanicals for the control of cashew powdery mildew disease. Mtwara and Lindi regions are located in the southern part of Tanzania, and which is characterized by a unimodal type of rainfall lasts for 4 to 5 or 6 months, that is, from November/December to April/May with the annual rainfall that ranges from 810 to 1090 mm. The mean temperatures ranged between 27°C (maximum) and 23°C (minimum). These studies were conducted during reproductive phases of cashew which occur between June and October[28].

Field preparation and layout of experiments: The farm fields were mowed and cleared to a good sanitary status using tractor power. A Randomized Complete Block Design (RCBD), with four replications and two cashew trees forming net plots, was used. Five panicles from both north and south sides (ten panicles of each test tree canopy) were tagged with numbered plastic labels, showing the replicate treatment numbers, and the name of the treatment. The adjacent trees surrounding the net plots acted as guard rows. All tagged panicles were assessed for mildew infection in a fortnight's interval from July to September in each year.

Preparation of plant extracts: About 500g of leaf/stem material of each of the tested plants namely, *Opuntia ficus-indica, Opuntia vulgalis, Euphobia tirucalli, Azadirachta indica* and *Bobgunnia madagascariensis* were collected from the botanical garden which was established at Naliendele Agricultural Research Institute. The 500g plant extracts were later ground by locally made mortar and pestle and sieved separately. The ground plant sample, which was obtained from each lot, was mixed with 1 litre of water in the bucket and left on a bench for about 24 hours to allow the extraction of pesticide to take place.

Treatments applications and assessment of powdery mildew disease: After 24 hours, about 500mls were collected from each of the extract solutions and sprayed on the ten panicles of the respective cashew trees. A chemical fungicide, Triadimenol 250 EC was used at a rate of 15 mls/litre of water as a control. The untreated trees were sprayed with water. A knapsack hand sprayer was used in the application of fungicides and the spraying was done in a fortnight's interval.

Data analysis: During the assessment, the percentage of panicles which were affected by PMD was estimated using six classes[29] as follows: 0 meant no mildew infection was observed; 1 1-10% meant mildew infection on panicles was observed (at an average of 5.5); 2 11-25 (18); 3 26-50 (38); 4 51-75 (63); 5 76-99 (87.5) and 6 = 100% PMD infection. The PMD percentage mean infections were analysed by using JMP 10.0.0[30]. The percentage means for mildew infection in each treatment were also graphically presented in each scoring date.

Results and discussion

The PMD infection trends: Figures 1-4 show the percentage of PMD on treated and untreated cashew trees. There was an increase in PMD severity as the season progressed from July to September in both years 2014 and 2015. The results indicated that PMD ranged from 0% (in July) to above 96% (in September) in cashew trees under the experiments. The PMD infection was less than 10% in Triadimenol treated cashew trees across locations and seasons. There was less than 60% of PMD infection in botanicals treated cashew trees from July to August. However, the PMD infection reached 71.85% in *E. tirucalli* treated cashew trees in September, 2015 at Naliendele site. Untreated cashew trees recorded 50% to above 96% of PMD infection in August across the sites and seasons.

Discussion: This study revealed that, the tested botanicals have the potential of suppressing cashew powdery mildew growth, however, mildew management ability varied among the tested botanicals. The PMD pressure was high (88% to 98%) on the untreated cashew trees indicating the presence of enough *O.anacardii* inoculum for the tested botanicals. Having higher mildew percentage in the untreated cashew trees also imply that, the disease will continue to be a serious problem in cashew yield reduction if it is not controlled. Similarly[9] reported cashew yield loss of between 70% and 100% for having PMD not controlled. The most promising plant extract against *O.*

anarcadii was from *O. ficus-indica.* Cashew trees treated with extract from *O. ficus-indica* consistently recorded lower PMD infection as compared to the tested botanicals. This was followed by *A. indica* and *O. vulgaris* though their ability to control the disease was inconsistence. The efficacy of plant extract depends on the type of solvent, plant material and extraction methods. For instance; the use of organic solvent provides more consistent antimicrobial activity compared to water extracts[33]. Therefore, consistent results can be obtained from *A. indica* and *O. vulgaris* if different solvents and extraction methods are tested. Cashew flowers treated with triadimenol, a synthetic fungicide, recorded the lowest PMD infection. Triademenol is a member of Demethylation Inhibitor (D.M.I), triazole fungicide which is a systemic broad spectrum, foliar fungicide causes abnormal fungal growth and eventually death[31]. Triadimenol has been recommended and registered for the control of cashew powdery mildew disease in Tanzania[8-10].

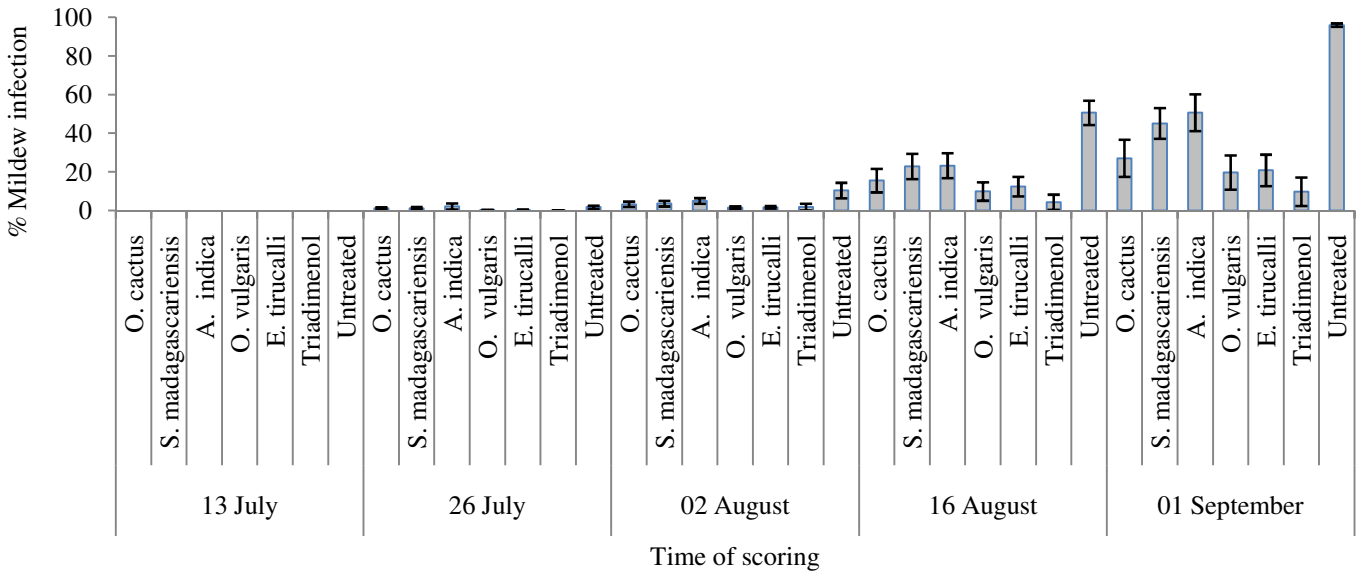

Figure-1: Percentage powdery mildew disease infection recorded in each cashew tree after application of treatments, from July to September, 2014 at Mkumba-Nachingwea site, Mtwara, Tanzania.

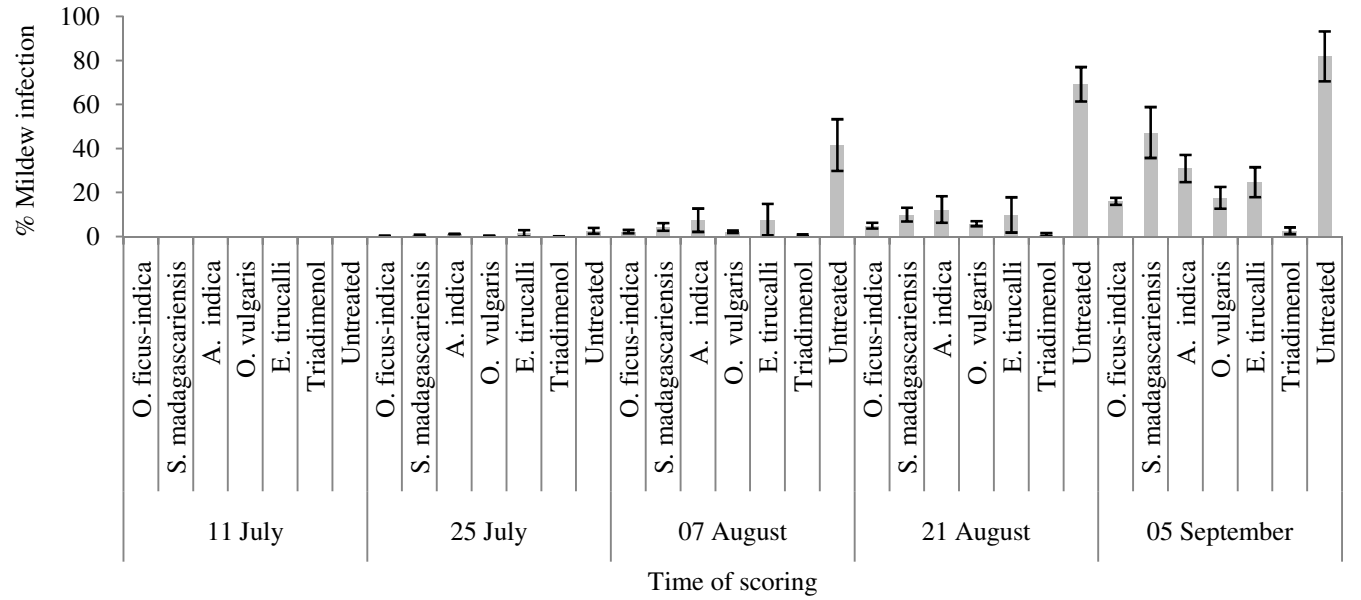

Figure-2: Percentage powdery mildew disease infection recorded in each cashew tree after application of treatments, from July to September, 2014 at Naliendele site, Mtwara, Tanzania.

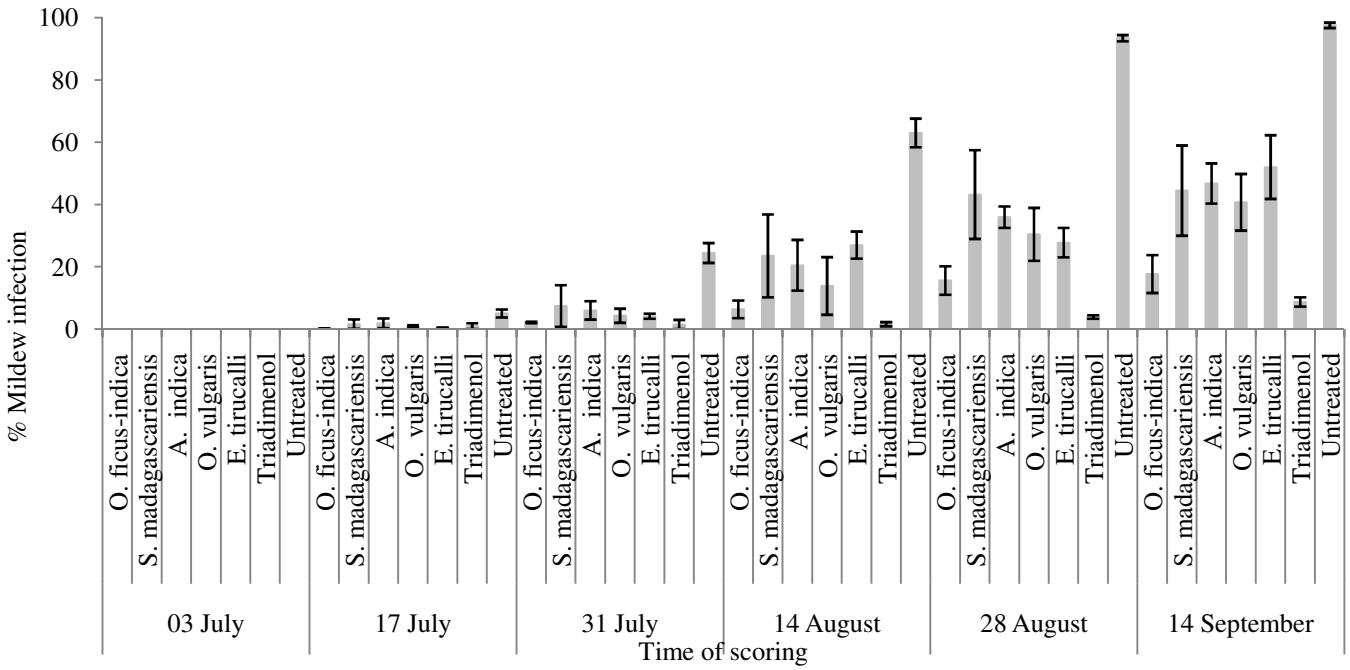

Figure-3: Percentage powdery mildew disease infection recorded in each cashew tree after application of treatments, from July to September, 2015 at Mkuma-Nachingwea site, Mtwara, Tanzania.

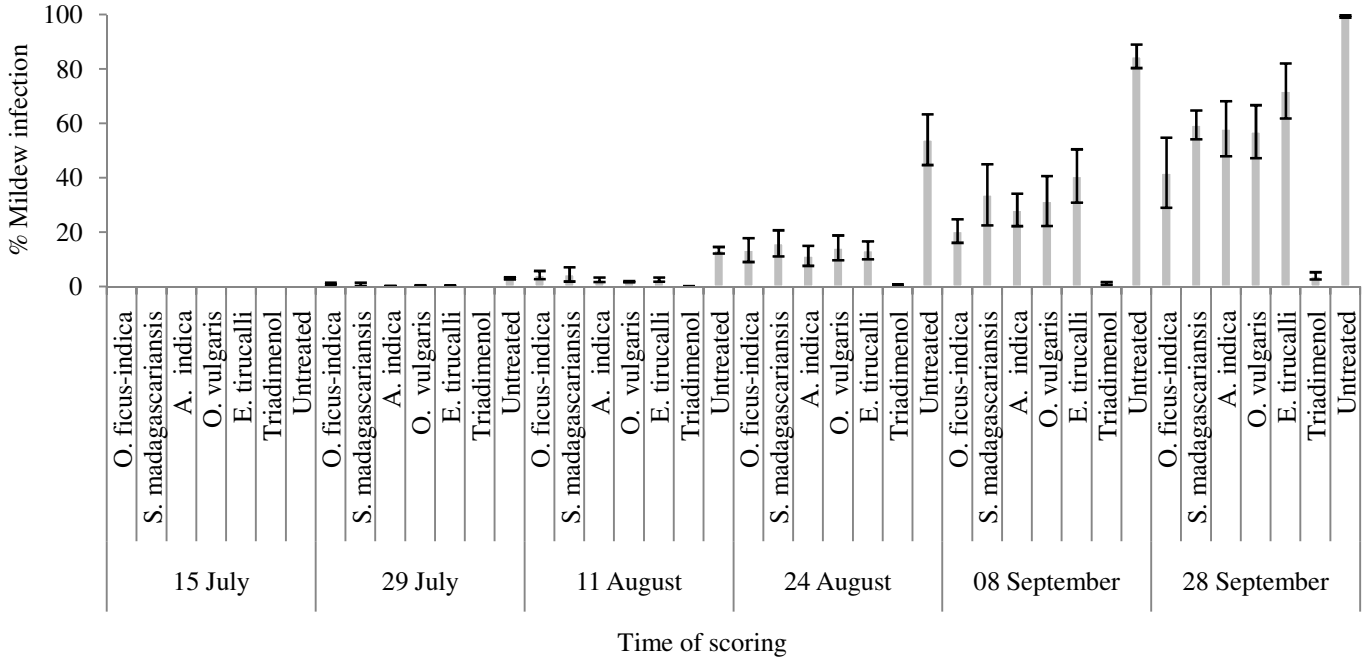

Figure-4: Percentage powdery mildew disease infection recorded in each cashew tree after application of treatments, from July to September, 2015 at Naliendele site, Mtwara, Tanzania.

An increase in the PMD severity was observed as the season progressed from July to September in both years 2014 and 2015 in all locations. Observation in the experimental plots showed that, PMD infection starts on new flush leaves thereafter on the flowers. Generally, the results indicated that PMD ranged from 0% in early July to above 96% in September. The PMD severity reached its peak between September and early October. July and September is a period with cooler conditions, with little rain and dry windy favouring mildew infection and dispersal of conidia[9]. Thus, infection occurs rapidly on the shoots, leaves and

panicles. Flower buds were observed to have been attacked before opening and the infected flowers appeared necrotic, fail to open and frequently abscise.

In this study, water was used as universal solvent[14]. However, other solvents such as methanol and ethanol are used in the research of antimicrobial activity in plants[14]. Other studies indicated that, tannins and other phenolics are effectively extracted with the use aqueous acetone than in aqueous methanol, and chloroform is the most effective solvent for extraction of non-polar biological active compound[32]. Plant extracts from *A. indica* and *O. vulgaris* showed inconsistence in managing PMD, therefore other solvents can be used for further investigation of microbial activity from these botanicals.

Conclusion

The present study indicated that plant extracts from *O. ficus-indica* appear to be better substitutes, under field conditions, to the management of pathogenic fungi than fungicides which are harmful to the environment, are costly and are less accessible by farmers. Plant extracts from *O. ficus-indica*managed to control PMD under field conditions unlike most of the plant extracts which are in vitro efficacy[14]. However, further studies are needed to identify chemical compounds contained in these tested botanicals.

Acknowledgement

This research was carried out by the Naliendele Agricultural Research Institute under the Cashew Research Programme. The study was financed by the Government of Tanzania. We wish to thank Betram Barnabas and AbilahWarambo for their support during the field activities.

References

1. Wakabi W. (2004). African Cashews to Indian Factories*:* how the continent Exports its Profits and Jobs. *East African Business* [http://organiccashewnuts.com/ casheafricajobsarticle.htm] site visited on 15/4/2017.

2. Masawe P.A.L. (2006). Tanzania cashew cultivars. Cashew Research Programme, Mtwara, Tanzania. ISBN 9987-446-01-9

3. NARI (2007). Cashewnut Production Handbook, Dar-es-salaam. Premadasa Colour Scan (T) Ltd, 1-51. ISBN 998744604-3.

4. Nene W., Rwegasira G.M. and Mwatawala M. (2016). Temporal abundance of African weaver ant, *Oecophyllalonginoda* (Hymenoptera: Formicidae) under unimodal rainfall pattern in Tanzania. *Biocontrol Science and Technology*, 26(4), 539-547.

5. Mitchell D. (2004). Tanzania's Cashew Sector: Constraints and Challenges in a Global Environment. Africa Region Working Paper Series No. 70 [http:// www.worldbank.org/afr/wps/ wp70] site visited on 21/7/2017.

6. Waller J.M., Nathaniels N.Q.R., Sijaona M.E.R. and Shomari S.H. (1992). Cashew powdery mildew (*Oidium anacardii*) in Tanzania. *Tropical Pest Management*, 38(2), 160-163.

7. Sijaona M.E.R. and Mansfield J.W. (2001). Variation in the response of cashew genotypes to the targeted application of fungicide flower panicles for control of powdery mildew disease. *Plant Pathology*, 50(2), 244-248.

8. NARI (2011). Cashew Research Programme Annual Report. Mtwara, Tanzania, 1-113.

9. Sijaona M.E.R. (2013). Important diseases and Insect Pests of Cashew in Tanzania. *Naliendele Agricultural Research Institute, Tanzania*, 1-44.

10. Magani S.F., Nene W. and Shomari S.H. (2015). Assessing factors limiting the adoption of pesticide use technologies in Cashew production. A case study in Mtwara District, Tanzania. Proceedings of the 3rd International Cashew conference, Serena Hotel, Dar es salaam, Tanzania 16-19 November, 2015.

11. Hajek A. (2004). Natural Enermies. An Introduction to Biological Control. Cambrige University press, Department of Entomology, Cornell University.

12. Tholkappian C. and Rajendran S. (2011). Pesticide Application and its Adverse Impact on Health: Evidences from Kerala. *International Journal of Science and Technology*, 1(2), 56-59. [http://www.ejournalof sciences.org] site visited 12/1/2017.

13. De Bon H., Huat J., Parrot L., Sinzogan A., Martin T., Malézieux E. and Vayssières J.F. (2014). Pesticide risks from fruit and vegetable pest management by small farmers in sub-Saharan Africa. A review. *Agronomy for Sustainable Development*, 34(4), 723-736. doi 10.1007/s13593-014-0216-7.

14. Gurjar M.S., Ali S., Akhtar M. and Singh K.S. (2012). Efficacy of plant extracts in plant disease management. *Agricultural Sciences,* 3(3), 425-433. [http:// dx.doi.org /10.4236/ as. 2012.33050] site visited 3/4/2017

15. Van Mele P. (2008). A historical review of research on the weaver ant Oecophylla in biological control. *Agricultural Forest Entomology*, 10, 13-22.

16. Satish S., Mohana D.C., Ranhavendra M.P. and Raveesha K.A. (2007). Antifungal activity of some plant extracts against important seed borne pathogens of Aspergillus sp. *Journal of Agricultural Technology*, 3, 109-119.

17. Babu B.H., Shylesh B.S. and Padikkala J. (2001). Antioxidant and hepatoprotective effect of Acanthus Iliciofilus. *Fitoterapia*, 72(3), 272-277.

18. Guerin J.C. and Reveille H.P. (1984). Antifungal activity of plant extracts used in therapy: Study of 41 plant extracts against 9 fungi species. *Annales Pharmaceutiques Francaises,* 42, 553-559.

19. Natarajan M.R. and Lalithakumari D. (1987). Antifungal activity of the leaf extracts of Lawsoniainermis on Drechsleraoryzae. *Indian Phytopathology,* 40(3), 390-395.

20. Singh R.K. and Dwivedi R.S. (1987). Effect of oils on Sclerotiumrolfsii causing foot-rot of barley. *Indian Phytopathology,* 40, 531-533.

21. McGrath M. (2012). Biopesticides for Managing Plant Diseases Organically. [http://www.longislandhort. cornell.edu/vegpath/organic.html] site visited on 12/6/2017.

22. Daoud A.S., Qasim N.A. and Al-Mallah N.M. (1990). Comparison study on the effect of some plant extracts and pesticides on some phytopathogenic fungi. *Mesopotamia Journal of Agriculture*, 22(4), 227-235.

23. Slusarenko A.J., Patel A. and Portz D. (2008). Control of plant diseases by natural products: Allicin from garlic as a case study. *European Journal of Plant Pathology*, 121(3), 313-322.

24. Yin M.C. and Cheng W.S. (1998). Inhibition of *Aspergillus niger* and *Aspergillus flavus* by some herbs and spices. *Journal of Food Protection*, 61(1), 123-125.

25. Chandel S. and Sharma S. (2014). Botanicals, biofumigants and antagonists application in managing stem rot disease caused by Rhizoctoniasolani Kuhn in carnation. *Journal of Biopesticide*, 7(1), 3-10.

26. Kuri S.K., Islam R.M. and Mondal U. (2011). Antifungal potentiality of some botanical extracts against important seedbornd fungal pathogen associated with brinjal seeds, Solanum melongena L. *Journal of Agricultural Technology*, 7(4), 1139-1153.

27. Mokhtar M.M., El-Mougy N.S., Abdel-Kareem F., El-Gamaal N.G. and Fatouh Y.O. (2014). Effect of Some Botanical Powdered Plants against Root Rot Disease Incidence of Bean under Field Conditions. *International Journal of Engineering and Innovative Technology*, 4, 162-167.

28. Nene W., Rwegasira G.M., Nielsen M.G., Mwatawala M. and Offenberg J. (2016). Nuptial flights behaviour of the African weaver ant, *Oecophyllalonginoda* Latreille (Hymenoptera; Formicidae) and weather factors triggering flights. *InsectesSociaux*, 63(2), 243-248.

29. Nathaniels N.Q.R. (1996). Methods including visual keys for assessment of cashew powdery mildew (*Oidium anacardii* Noack) severity. *Int.J.Pest Manage*., 42(3), 199-205.

30. Statistics J.M.P. and graphics guide (1995). SAS Institute inc. *Cary, NC*.

31. Triadimenol 250 EC fungicide. [http://www.herbiguide. com.au/Labels/TRIA250_52067-0102] site visited on 24/10/ 2016.

32. Harmala P., Vuorela H., Tornquist K. and Hiltunen R. (1992). Choice of solvent in the extraction of Angelica archangelica roots with reference to calcium blocking activity. *Planta Medica*, 58(2), 176-183.

33. Parekh J., Jadeja D. and Chanda S. (2005). Efficacy of aqueous and methanol extracts of some medicinal plants for potential antibacterial activity. *Turkish Journal of Biology*, 29, 203-210.