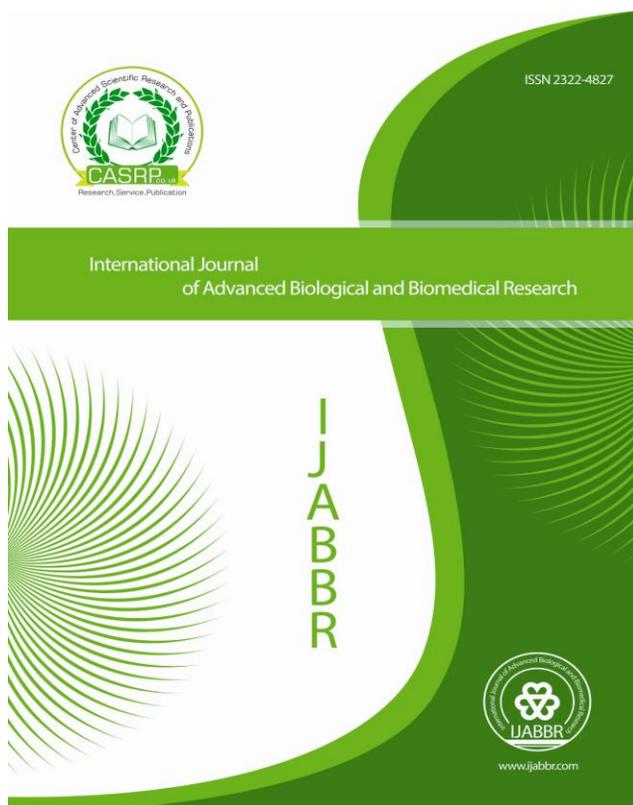


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Original Article

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Composition, distribution and economic importance of insect pests of prioritized aromatic plants in some growing of Ethiopia

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Abstract

Ethiopia is remarkably rich in its biological, ecological and landscape diversity and is home to outstanding natural bio-resources such as a number of herbs, aromatic and medicinal plants. The present study was carried out to study the composition, distribution and economic importance of insect pests of prioritized aromatic (*Mentha* sp., lemon verbena, fennel, rosemary, rosadamascente, oregano, palmarosa, lemon grass, rose scented geranium) plants between 2013 to 2015 in some growing area of Ethiopia. 10 to 20 random sample units (plants) were taken to assess pest prevalence from each of the upper, middle and lower canopy layers of the main stem. Sample pests and infected plant parts were taken and examined in Wondo Genet Agricultural Research Center. The species were later on got identified from different sources. The result showed that *Agrotis* sp., *Dysaphsfoeniculus*, *Iceryapurchasi*, *Melanchrpicta*, *Papaipemanebri*, *Rhodobiumorosum* were the major insect pests where as *Tetranychus* spp., *Dicyphus* spp., *Myzuspersicae*, *Odontotermesspp.*, *Ornithacris* sp. and *Ovatuscrataegarius* were minor insect pests recorded feeding of prioritized aromatic plants. In all 12 insect species belonging to 5 orders were recorded to be associated with (8) aromatic plants in the survey area of Ethiopia. All these insect-pests were recorded in very low to very high causing damage. This study important for understanding the situation of aromatic plants insect pests that will help to eventually achieve an economically sound and efficient pests management strategy.

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Keywords: Insect-pests, Prioritized aromatic plants, Infestation, Damage level.

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1. Introduction

Ethiopia is remarkably rich in its biological, ecological and landscape diversity and is home to outstanding natural bio-resources. The flora of Ethiopia is estimated to be between 6,500 and 7,000 species, of which 10 -12 percent is considered to be endemic making the country one of the most diverse floristic regions in the world. Cultivation of aromatic in Ethiopia has remained predominantly traditional over the centuries, being produced mainly by smallholder farmers operating on small plot of land around homestead and in natural forests. Aromatic plants are plants which possess odoriferous oil in either of their organs or product, sometimes even in the whole plant which can be used for cosmetics, pharmaceuticals, aromatherapy and soap and detergent manufacturing (Solomon and Beement, 2010).

The development of aromatic plants sub sector has diverse benefits for environment, additional income generation for the poor and small holder farmers, plays a significant role in import substitution, contributes for agricultural diversification for export promotion and creates valuable job opportunities for large number of people provide remarkable benefits to the national economy. Many inattentive plants especially aromatic plants are considered as multipurpose and are important to produce valuable substances, essential oils and oleoresins and original aroma useful for agro food, aromatherapy and soap, detergent manufacturing and cosmetic industries (Rubatzskey et al., 1999).

However, like agricultural crops various constraints pose serious problem for cultivation of aromatic plants viz. nutrient management, water management, suitable genotype, agro-climatic condition, insect pests, and diseases and weed management. Therefore, to obtain large quantity of good quality of aromatic plants, not only high yielding varieties are to be involved and grown under optimum agronomical conditions, they require to be protected from diseases and pests (Rao, 2000). It is thus, very imperative to identify and protect the plants from different insect pests to derive maximum benefit from aromatic and plants. The information regarding the occurrence and economic importance of insect-pests on aromatic plants of the country is scanty. So to design effective controlling strategy for these biotic stresses, identification and distribution of major insect pests of aromatic plants is found essential. Therefore, the objective of this study was to identification and determination of economic importance of insect pests of prioritized aromatic (*Mentha* sp., lemon verbena, fennel, rosemary, rosadamascene, oregano, palmarosa, lemon grass, rose scented geranium) plants.

2. Materials and methods

The survey was carried out at Wondo Genet, Hawasa, Alagae, Koka, DabraZait, Managasha and Hollata stations from 2013 to 2015 at vegetative and maturity growth stages of aromatic, medicinal and biofuel plants. In these locations the plants grown for the purpose of different research and private for commercial (Hawasa Green Mark Herbs PLC.). List of priority aromatic plants selected for insect pests survey was showed as follows. *Mentha* spp., lemon verbena (*Aloysiatripylla* L.), fennel (*Foeniculumvulgare*L.), rosemary (*Rosemarinusofficinalis*L.), rosadamascene (*Rosa damascene* Mill), oregano(*Origanumvulgare*), lemon grass (*Cymbopogoncitratus* L.), palmarosa (*Cymbopogon martini* L.) and rose scented geranium (*Pelargonium graveolens* L.) were the major aromatic plants that focused insect pest survey take place.

2.1. Description of the study areas

Depending upon the availability of plants 10 to 20 random sample units (plants) were taken to assess pest prevalence from each of the upper, middle and lower canopy layers of the main stem. Moreover, sample infested plant parts and insect pests were collected from the same selected sampling fields and brought to Wondo Genet Agriculture Center plant protection laboratory for further identification of insect pests. During survey, necessary information on damaging stage of the pest, weather condition, plant age or stage, etc, were collected critically. Identifications processes were done in collaboration with Ambo Plant Protection and Addis Ababa University. And also the species were later on got identified from different sources. The insect damage scale was assigned according to Seif and Hillocks (1999) that states very low ($\leq 5\%$), low (6-10%), medium (11-20%), high (21-50%) and very high ($> 50\%$) levels. Data such as number of infested plants versus total number plants, damaged plant parts versus total area of plant tissue were recorded to determine percent incidence (infestation) and severity (damaged level). Incidence and severity of pests from the attacked plants, was calculated by using the following formula.

$$\text{Per cent infestation} = \frac{\text{Number of infested plants}}{\text{Total number of observed plant}} \times 100$$

$$\text{Damage level} = \frac{\text{Area of plant tissues infested by pest}}{\text{Total area of plant (tissue)}} \times 100$$

Table 1

Site description of insect pests survey areas in Ethiopia.

| Survey area | Latitude | Longitude | Soil PH | Soil types | Rain fall (mm) | Altitude (m.a.sl) | Annual average temperature(^o C) | |
|-------------|-----------------------|------------------------|---------|-----------------------------|----------------|-------------------|---|---------|
| | | | | | | | Minimum | Maximum |
| Wondo Genet | 7 ^o 192' N | 38 ^o 382' E | 6.4 | Sandy clay loam (Nitosol) | 1000 | 1876 | 12.02 | 26.72 |
| Hawasa | 7 ^o 05' N | 39 ^o 29' E | 7.2 | Sandy loam (Andosol) | 964 | 1652 | 12.94 | 27.34 |
| Debra zeit | 8 ^o 44' N | 38 ^o 58' E | 6.9 | Black heavy Clay (Vertisol) | 851 | 1891 | 12.22 | 25.72 |
| Allagae | 7 ^o 43' N | 38 ^o 36' E | 8.4 | Clay loam | 510 | 1594 | 13.44 | 26.61 |
| Koka | 8 ^o 26' N | 39 ^o 1' E | - | Clay soil | 830.9 | 1604 | 13.68 | 28.30 |
| Hollata | 9 ^o 03' N | 38 ^o 30' N | | Red brown clay loam soil | 1100 | 2390 | 6.13 | 22.2 |

Source: Beemnet et al., 2010.

3. Results and discussion

3.1. Composition, distribution and economic importance of insect pests

The present survey revealed distribution, composition and economic importance of insect pests of prioritized aromatic plants in some parts growing area of Ethiopia between 2013 and 2015 (Table 2). In all 12 insect species belonging to 5 orders were recorded to be associated with (8) aromatic, plants in the survey area of Ethiopia. All these pests were recorded in very low to very high infestation rate and causing low to moderate damage level.

The information recorded with respect to incidence of different insect pests on different aromatic plants during survey study was given in Table 2. These are being discussed plant-wise as follows:

3.2. Insect pests associated with *Mentha* Sp.

Aphids (*Myzus persicae* Sulzer) and green aphid (*Ovatus crataegarius* (Walker) with 10% infestation rate in Wondo Genet were minor insect pests where as cut worm (*Agrotis* sp.) with 5% infestation rate in Koka was the major pest recorded from mint (Fig. 1b). *Agrotis* sp. is also the minor insect pest of *Rosa damascene* and *Pelargonium graveolens* (Table 2). Insect pests of mint (*Mentha* sp.) feed plants were found to be important reduce biomass yield and quality in our study. This pest may be serious in the future and close follow up is important. Those insect pest damages leave parts of the mint and randomly distributed at the survey areas. The damage can reduce the yield and quality mint production. Similarly conducted by Buckland, K. and Drost, D. (2009) stated that aphids (*Myzus persicae*) and cutworms (*Agrotis* sp.) were the major pests of mint in America which is agreement with our findings. Additionally, they were also identified that thrips (*Frankliniella occidentalis*) and spider mites (*Tetranychus urticae*) were the major pests of mint.

3.3. Insect pests associated with Fennel

Fennel (*Foeniculum vulgare* L.) is a flowering plant species in the carrot family. It is a hardy, perennial herb with yellow flowers and feathery leaves. It is indigenous to the shores of the Mediterranean but has become widely naturalized in many parts of the world including Ethiopia. It is a highly aromatic and flavorful herb with culinary and medicinal uses and, along with the similar-tasting anise, is one of the primary ingredients of absinthe. Florence fennel or finocchio is a selection with a swollen, bulb-like stem base that is used as a vegetable (US Department of Agriculture, Natural Resources Conservation Service, 2015). The

health benefits of fennel include relief from anemia, indigestion, flatulence, constipation, colic, diarrhea, respiratory disorders, menstrual disorders, and its benefits regarding eye care. Fennel aphid (*Dysaphisfoeniculus*) was the major insect pest recorded from fennel. It affect high damage level and infestation more than 30% rate in Wondo Genet during 2015. The pest was damages both leaves and stem and distributed randomly in the fields. Heavy population of fennel aphids can turn leaves yellow and stunt shoots resulted to losses seed yield (Fig. 1c). According to Ramalho et al. (2013) fennel aphid, *Hyadaphisfoeniculi* (Passerini) (Hemiptera: Aphididae) is a major pest of fennel in northeast region of Brazil and reduced the fennel seed yield by 80% in the sole fennel plots compared with 30% for all intercropping systems. This pest may become serious pest in our country as in Brazil and it can be serious in our country in the future.

3.4. Insect pests associated with Rosemary

Rosemary (*Rosemarinusofficinalis*L.) plant which is collected from the wild and cultivated in the home garden of farmers is utilized as spices and food additives since early time in Ethiopia. Growing area of the rosemary are Shewa, Sidama, Ilubabor, Arsi and Welo area (Beemnet et al., 2009). The leaves and essential oils (EOs) are the economic products of rosemary. Dried and fresh leaves are directly used as a culinary herb and EOs extracted from leaves are extensively used in food flavoring and fragrance industries (Beemnet et al., 2009; Mishra et al., 2009). These rosemary plant may have coevolved with various insect pests for many years and/or some of them could have resisted and continue to grow until today. However, during this survey time, cottony cushion scale (*Iceryapurchasi* Maskell) was major insect pest recorded from the rosemary plant with 25% infestation rate and was widely distributed in most of the survey areas (Fig. 1e). Cottony cushion scale feeds from the phloem of the host plant mainly found on stems, leaves and green twigs. Heavy infestation results in yellowing, defoliation, reduction in fruit set and loss in plant vigor. Direct damage caused by soft scales is due to the actual feeding of the scale on the host plant. Indirect damage can occur as the growth of sooty mold associated with honeydew production and it can be serious in our country in the future.

3.5. Insect pests associated with Lemon Verbena

Cutworm (*Agrotis* sp.) was the minor insect pest recorded feeding lemon verbena (*Aloysiatripylla* L.) with 10% infestation rate and causing medium damage level (Fig. 1d).

3.6. Insect pests associated with Damaskrose

Damask rose (*Rosa damascene* Mill) is one the aromatic plants and planted for the research porpuse at different research and farm station through Wondo Genet Agriculture Research Center. Rose aphid (*Rhodobium porosum* Sanderson) was one of serious pest recorded feeding on damask rose with 70% infestation rate and cousing moderate in Wondo Genet (Fig. 1h). Large populations of aphids can turn leaves yellow and stunt shoots; aphids can also produce large quantities of a sticky exudate known as honeydew, which often turns black with the growth of a sooty mold fungus. Some aphid species inject a toxin into plants, which causes leaves to curl and further distorts growth (Bugg et al., 2008). Cut worm (*Agrotis* sp.) was also major pest recorded from damask rose with 10% infastation rate in Holata research station with low damage level (Fig 1g). According to Margina et al. (1999) the cane borer (*Agiluscuprescens* Men.), rose curculio (*Homalorynchiteshungaricus* Fussly.), rose scale insect (*Rodoccocusbulgariensis* Wunn.), rose chafer (*Epicometishirta* Poda.) and *Phyllopertahorticola* proved to be the most destructive of the rose attacking pests that are differ from our findings. This different may due to different agro ecology of our study areas.

3.7. Insect pests associated with Oregano

Oregano (*Origanumvulgare*L.) is native to the Mediterranean, Europe (including the British Isles) and south and central Asia, and is cultivated elsewhere including in Ethiopia. Oregano is used in traditional medicine for treating colds, indigestion and stomach upsets (<http://www.kew.org/science-conservation/plants-fungi/origanum-vulgare-oregano>). During survey time termite (*Odontotermes* sp.) was the minor insect pest recorded from oregano with 15% infestation rate in Koka. The pest affects leaves, stem and root that reduce yield and quality of oregano production and randomly distributed in field. There is no report on the occurrence of insect pest on oregano in literature.

Table 2

Distribution, composition and damage extent of insect of insect pests of prioritized aromatic between 2013-2015.

| Hosts | Sites | Insect Pests | | | | Plant part damage | Distributions | Infestation (%) | Damage level (%) |
|----------------------------|------------------------|-----------------------|-------------|---------------|-----------------------------------|-----------------------|---------------|-----------------|------------------|
| | | Common name | Order | Family | Scientific name | | | | |
| Menthasp | Wondo Genet | Aphids | Hemiptera | Aphidae | Myzus persicae (Sulzer)* | Leaves | randomly | 10 | 5 |
| | Koka | cut warm | Lepidoptera | Noctuidae | Agrotis spp.*** | Leaves | randomly | 5 | 15 |
| | Wondo Genet | Green aphid | Hemiptera | Aphidae | Ovatus crataegarius (Walker)* | Leaves | randomly | 10 | 3 |
| Aloysiatripylla L. | Wondo Genet | Cut worm | Lepidoptera | Noctuidae | Agrotis sp.*** | Leaves | entire field | 10 | 20 |
| Foeniculum vulgare L. | Wondo Genet | fennel aphids | Hemiptera | Aphidae | Dysaphis foeniculus**** | Leaves and stem | randomly | 30 | 35 |
| Rosemarinus officinalis L. | * at all growing area | cottony cushion scale | Hemiptera | Argaridae | Icerya purchasi Maskell** | Leaves | randomly | 25 | 20 |
| Rosa damascena Mill | Wondo Genet | Rose aphid | Hemiptera | Aphidae | Rhodobium rosarum (Sanderson)**** | Leaves and stem | entire field | 70 | 25 |
| | Hollata | Cut worm | Lepidoptera | Noctuidae | Agrotis spp.***** | Leaves | entire field | 10 | 50 |
| Origanum vulgare | Koka | Termite | Isoptera | Termitidae | Odontotermesspp.** | Leaves, stem and root | randomly | 15 | 8 |
| Cymbopogon citratus L | Barder | Termite | Isoptera | Termitidae | Odontotermesspp.* | Leaves, stem and root | randomly | 10 | 5 |
| | Koka | Spider mite | ACARI | Tetranychidae | Tetranychus spp.* | Leaves and stem | randomly | 6 | 5 |
| | Wondo Genet and Hawasa | stalk borer | Lepidoptera | Noctuidae | Papaipeman ebris (Guenée)*** | stem and leaves | randomly | 15 | 15 |
| Cymbopogon martini L | Wondo Genet | caterpillar | Lepidoptera | Noctuidae | Melanchrapi cta (Harris)*** | Leaves | entire field | 25 | 15 |
| Pelargonium graveolens L. | Wondo Genet | grass hopper | Orthoptera | Acrididae | Ornithacris sp.** | Leaves | randomly | 12 | 10 |
| | Wondo Genet | plant bug | Hemiptera | Miridae | Dicyphusspp.* | Leaves | randomly | 7 | 5 |
| | Wondo Genet | Cut worm | Lepidoptera | Noctuidae | Agrotis spp.* | Leaves | randomly | 5 | 3 |

* Wondo Genet, Hawasa, Koka, Hollata, Debra Zeit and Managasha. Key→ * = very low, ** = low, *** = medium, **** = high, ***** = very high (damage levels).

3.8. Insect pests associated with Lemongrass

Lemongrass (*Cymbopogon Citratus* L.) a perennial plant with long, thin leaves, is one of the largely cultivated medicinal plants for its essential oils in parts of tropical and subtropical areas of Asia, Africa and America by (Joy et al., 2006). It has long been introduced and maintained at Wondo genet and cultivated at different agro ecology for different research purpose. Lemongrass can be used as carminative (Kumari et al., 2009), insect repellent (Joy et al., 2006) and widely used as herbal tea (Beemnet et al., 2010). It has remedial properties and is used to treat bronchitis, sinusitis, cold, fever, malaria, hemorrhoids, toothache, as a baby oil, massage oil, body ointment, oil for rheumatism, beauty marks, herbal baths soap and candle- making industries and herbal recipes by Hirt and Mpia (2001). During survey, termite (*Odontotermes* sp.) at Barder area with 10% infestation rate and spider mite (*Tetranychus* sp.) 6% infestation level in Koka were minor insect pests feeding lemongrass where as stalk borer (*Papaipemanbris* (Guenée) with 15% infestation rate was major insect pest in Wondo Genet and Hawasa. The insect pests affect leaves and shoot that can reduce yield and quality essential oil and randomly distributed in the cultivated field. Those pests especially borer needs critical follow up to manage and it may become serious pest in our country (Fig. 1a).

3.9. Insect pests associated with Palmarosa

Palmarosa (*Cymbopogon martini* L.) is a perennial herb, widely distributed in tropical and subtropical regions (Khanuja et al., 2005). It is cultivated in the most farmer garden for purpose of food flavor in small amount in Ethiopia. It contains essential oil, whose main components are geraniol and geranyl acetate (Khanuja et al., 2005). The essential oil from *C. martini* is widely used as a flavoring for food, beverages and snuff products, as a valuable component for perfumes, cosmetic and pharmaceutical products, and against the action of various bacteria, fungi and microorganisms (Teixeira et al., 2005). Caterpillar (*Melanhrapicta* Harris) was the minor insect pest recorded from palmarosa at Wondo Genet with 25% infestation rate, low damage level and randomly distributed in the field. There is no report on the occurrence of insect pest on palmarosa in literature.

3.10. Insect pests associated with Rose Scented Geranium

Rose Scented Geranium (*Pelargonium graveolens* L.) grows for production of essential oil from its leaves, tender shoots and flowers by using steam- and/or hydrodistillation by (Shawl et al., 2006; Verma et al., 2011). Grass hopper (*Ornithacris* sp.) with 12% infestation rate, plant bug (*Dicyphus* sp.) with 7% infestation rate and cut worm (*Agrotis* sp.) with 5% infestation rate were minor insect pests recorded during survey time at Wondo Genet from *P. Graveolens* within causing low to medium damage. Those pests affect leaves and randomly distributed in cultivated field and can reduce yield and quality of essential oil. Dereje et al., (2009) reported that sciarid flies, flower thrips and white fly were important pests of *P. graveolens* that are differ from our findings. This difference may due to limitation of study area and/or agro ecology. So further study will be important.



a. Borer (*Papaipemanbris*) on *Cymbopogon* sp.



b. Cutworms (*Agrotis* sp.) on *Mentha* sp.



c. Fennel aphids (*Dysaphsfoeniculus*) on *F. vulgare*.



d. Cut worms (*Agrotis* sp.) on *A. triphylla* L.



e. Cottony cushion scale (*Icerya purchasi*) on *R. officinalis* L.



f. *Myzuspersicae* (Sulzer) on *Mentha* sp.



g. Cut worms (*Agrotis* sp.) on *R. damascene*.



h. Roseaphids (*Rhodobiumporosum*) on *R. damascene*.

Fig. 1. Insect-pests associated with prioritized aromatic plants in some growing area in Ethiopia.

4. Conclusion

The present study provided some clues to the understanding of the distribution, composition and economic importance of insect pests of prioritized aromatic (*Mentha* sp., lemon verbena, fennel, rosemary, rosadamascene, oregano, palmarosa, lemon grass, rose scented geranium) plants in some growing of Ethiopia. The result showed that *Agrotis* sp., *Dysaphsfoeniculus*, *Iceryapurchasi*, *Melanchrpicta*, *Papaipemanebris*, *Rhodobiumorosum* were the major insect pests where as *Tetranychus* spp., *Dicyphusspp.*, *Myzuspersicae*, *Odontotermesspp.*, *Odontotermesspp.*, *Ornithacris* sp. and *Ovatuscrataegarius* were minor insect pests recorded feeding of prioritized aromatic plants. Thus, further evaluation of the wide genetic base of aromatic plants, damage and loss assessment due to the major pests, and control options are required. The major aromatic plants growing areas of other parts of Ethiopia should be surveyed as the current survey is not inclusive of all areas due to logistic problem. Periodic survey should be carried out to monitor the pest's status as production system and environmental

conditions are dynamic to regulate pest population and their economic importance. At this stage the economic status of various species is not well defined and the corresponding thresholds are not worked out. Since those crops has attained high importance as supplement to produce valuable substances, essential oils and oleoresins and original aroma useful for agro food and cosmetic industries. It is necessary to develop cost effective pest management practices with environmental concern.

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References

- Beemnet, M., Omarsheerif, M., Tsion, T., Solomon, A., 2010. Production, proceessing and utilization of aromatic plants, Ethiopia Institute of Agricultural Research (EIAR), Addis Ababa, Ethiopia, 31.
- Beemnet, M., Omersherif, M., Tsion, T., Solomon, A., 2009. Production, processing and utilization of aromatic plants. Addis Ababa: EIAR.
- Buckland, K., Drost, D., 2009. Mint in the garden. Utah State Cooperative Extension. Available at:<http://extension.usu.edu/files/public...>
- Bugg, R.L., Colfer, R.G., Chaney, W.E., Smith, H.A., Cannon, J., 2008. Flower flies (Syrphidae) and other biological control agents for aphids in vegetable crops. Oakland: Univ. Calif. Agr. Nat. Res. Publ., 8285.
- Classification for Kingdom Plantae Down to Genus Foeniculum Mill, 2015. US Department of Agriculture, Natural Resources Conservation Service. Retrieved 24 March.
- Dereje Gorfu, Eshetu Ahmed, Abraham Tadesse, MekuriaTadesse, 2009. Disease and insect pests of aromatic, medicinal and Non-edible industrial oil bearing plants in Ethiopia. In Abraham Tadesse (ed.), Increasing crop production through improved plant protection. Addis Ababa: Plant Protection Society of Ethiopia (PPSE), 2, 462-473.
- Hirt, H.M., Mpia, B., 2001. Natural medicinal in the tropics I. Tropical plants as a source of health care. Production of Medicinal and Cosmotics, Action for Natural Medicinal (ANAMED), Winnernden Germany, 159.
- Joy, P.P., Baby, P.S., Samuel, M., Gracy, M., Ancy, J., 2006. Lemongrass: The fame of Cochin. India. J. Arecanut. Spic. Med. Plant., 8(2), 55-64.
- Khanuja, S.P., Shasany, A.K., Pawar, A., Lal, R.K., Darokar, M.P., Naqvi, A.A., Rajkumar, S., Sundaresan, V., Lal, N., Kumar, S., 2005. Essential oil constituents and RAPD markers to establish species relationship in Cymbopogon Spreng. (Poaceae). Biochem. Syst. Ecol. 33(2), 171 - 186.
- Kumari, J., Verma, V., Goyal, A., Shahi, A.K., Sparoo, R., Sangwan, R.S., Qazi, G.N., 2009. Genetic diversity analysis in Cymbopogon species using DNA markers. Plant. Omic. J., 2(1), 20-29.
- Margina, A., Lecheva, I., Craker, L.E., Zheljzkov, V.D., 1999. Diseases and Pests on Bulgarian Oil-Bearing Rose (Rosa Kazanlika V.T.=Rosa Damascena Mill. Var. Kazanlika). Acta Hort. 502, 237-242 DOI: 10.17660/ActaHortic.1999.502.38
- Mishra, A.C., Negi, K.S., Shukla, H.Y., Sharma, A.K., 2009. Effect of spacing on the performance of rosemary (RosemarinusofficinalisL.) blue flowered genotype (NIC-23416) in mid hills of Uttarakhand under rain fed conditions. Natural Product Radiance, 8(5), 528-531.
- Ramalho, F.S., Fernandes, F.S., Godoy, W.A.C., Pachu, J.K.S., Nascimento, R.B., Malaquias, J.B., Zanuncio, J.C., 2013. Within plant distribution and dynamics of hyadaphis foeniculi (Hemiptera: Aphididae) in field fennel intercropped with naturally colored cotton. Florida Entomologist, 96(1), 92-103.
- Rao, V.S., 2000. Principles of weed Science. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. 427-436.
- Rubatzskey, V.E., Quiros, C.F., Simon, P.W., 1999. Carrot and related vegetable umbelliferae. CABI Publishing, USA. 39-40.
- Seif, A.A., Hillocks, R.J., 1999. Some factors affecting infection of citrus by Phaeoramularia angolensis. Blackwell Wissenschafts-Verlog. Berlin ISSN, 093-11785.
- Shawl, A.S., Kumar, T., Chishti, N., Shabir, S., 2006. Cultivation of rose-scented geranium (Pelargonium sp.) as a cash crop in a Kashmir Valley. Asia. J. Plant. Sci., 5(4), 673-675.

Solomon Abate, Beemnet Mengesha., 2010. Bringing aromatic plants into cultivation by smallholder farmers of Ethiopia: Opportunities and challenges. Horticultural Society of Ethiopia.

Teixeira, D.M., Figueira, G.M., Sartoratto, A., Garcia, V.L., Delarmelina, C., 2005. Anticandida activity of brazilian medicinal plants. J. Ethnopharmacol., 97, 305 - 311.

Verma, R.K., Rahman, L., Verma, R.S., Kalra, A., Khanuja, S.P.S., 2011. Assessing N-use efficiency, planting time and economics of fertilizer N in rose-scented geranium (Pelargonium graveolens L. Herit) in Western Himalayan Region of India. Afr. J. Agr. Res., 6(3), 553-559.

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