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Original Research Article

Probing Green Pesticides in Dir Khyber Pakhtunkhwa Pakistan

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Abstract

The present study focuses survey of essential oils containing plants termed as `Green pesticides` in Dir Khyber Pakhtunkhwa, which is a high altitude region, rich in medicinally important species. 25 plant species of 10 genera belonging to 07 families are explored in 25 various locations during 10 field surveys. The species rich in essential oils possess pesticidal, insecticidal, antifeedant, repellent, ovipositor deterrent, growth regulatory and antivector activities. Among the explored species, 12 are abundantly available for large scale production of pesticides, 10 are rare while 03 species are vulnerable. Family Lamiaceae is found to consist of 07 important species. Recent investigations of 72 plant species worldwide signify some constituents interfere with the octopaminergic nervous system in insects, unlike mammals, make these chemical substances relatively non-toxic to mammals and fish in toxicological tests, and meet the criteria for "reduced risk" pesticides. Significance of this exploratory research work in countries like Pakistan, Afghanistan, India and Bangladesh, which are rich in endemic plant biodiversity lies in future integrated pest management (IPM) programs due to their safety to non-target organisms and the environment.

Keywords:*Green pesticides, antifeedant,pesticidal etc.*

Introduction

Negative impact on environment by extreme use of synthetic pesticides in the modern era is a serious concern for scientists and public. About 2.5 million tons of pesticides are used on crops each year and the worldwide damage caused by pesticides is about a $100 billion annually. High toxicity and no biodegradable characteristics of pesticides and the residues in soil, contaminate water resources and crops that upset public health. Therefore need for selective, cost-effective, productive, ecofriendly, and biodegradable pesticides and insecticides cannot be ruled out. Bioproducts are excellent substitutes to synthetic pesticides and are more compatible with the environmental components than synthetic pesticides (Isman and Machial, 2006).Thus in the present concept of green pesticides include plant extracts, hormones, pheromones and toxins from organic source that encompass many aspects of pest control such as microbial, entomophagous nematodes, plant derived pesticides, secondary metabolites from microorganisms, pheromones and genes used to transform crops to express resistance to pests. More recently, products from natural resources and extreme biodegradable synthetic and semi synthetic products in pest management, are in the umbrella of green pesticides (Koul *et al*., 2003; Koul 2005; Dhaliwal and Koul, 2007; Koul, 2008). Green pesticides are the by-products of plant metabolism found in glandular hairs or secretory cavities of plant-cell wall and are present as droplets of fluid in the leaves, stems, bark, flowers, roots and/or fruits in different plants. Their uses are as food additives, flavorings, and components of cosmetics, soaps, perfumes, plastics, and as resins.

The amount of essential oil in plants is quite variable i.e. 0.01 to 10%. In *Ocimum basilicum* (basil), methyl chavicol is upto 75% of the oil, β-asarone in *Acorus calamus* rhizomes is 70–80%, linalool in coriander seed and leaf oils is 50– 60%. Interestingly 2-decenol and decanal were the most predominant constituents in leaf oil (Lawrence and Reynolds, 2001).

Most essential oils comprise of monoterpenes - compounds that contain 10 carbon atoms often arranged in a ring or in acyclic form, as well as sesquiterpenes which are hydrocarbons comprising of 15 carbon atoms. But interest in the oils was renewed with emerging demonstration of their fumigant and contact insecticidal activities to a wide range of pests in the 1990s (Isman, 2000). The rapid action against some pests is indicative of a neurotoxic mode of action,

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and there is evidence for interference with the neuromodulator octopaminergic (Kostyukovsky *et al.*, 2002) by some oils and with GABA-gated chloride channels by others (Priestley *et al.*, 2003), the oils themselves or products based on oils are mostly nontoxic to mammals, birds, and fish (Stroh *et al*., 1998), therefore, justifying their placement under "green pesticides".

Several essential oils such as lemon grass (*Cimbopogon winteriana*), *Eulcalyptus globulus*, rosemary (*Rosmarinus officinale*), Vetiver (*Vetiveria zizanoides*), clove (*Eugenia caryophyllus*) and thyme (*Thymus vulgaris*) are known for their pest control properties. While peppermint (*Mentha piperita*) repels ants, flies, lice and moths; pennyroyal (*Mentha pulegium*) wards off fleas, ants, lice, mosquitoes, ticks and moths. Spearmint (*Mentha spicata*) and basil (*Ocimum basilicum*) are also effective in warding off flies. Similarly, essential oil bearing plants like *Artemesia vulgaris*, *Melaleuca leucadendron*, *Pelargonium roseum*, *Lavandula angustifolia*, *Mentha piperita*, and *Juniperus virginiana* are also effective against various insects and fungal pathogens (Kordali *et al.*, 2005). Extracts of *Foeniculum vulgare, Trachyspermum ammi, Cuminum cyminum, Syzygium aromaticum*, *Cinnamomum tamala* showed the most potent activity against all the microorganism studied *C. albicans* (MTCC-227), *C. glabrata* (MTCC-3016), *C. haemolonii* (MTCC-1966). On the contrary, *C. albicans*(MTCC-227), *C. glabrata*(MTCC-3016) and *C. haemolonii*(MTCC-1966) strains (Singh *et al*., 2013). Studies conducted on the effects of volatile oil constituents of *Mentha* species are highly effective against *Callosobruchus maculatus* and *Tribolium castanum*, the common stored grain pests (Tripathi *et al*., 2000).

The larvicidal activity of citronella oil has been mainly attributed to its major monoterpenic constituent citronellal (Zaridah *et al*., 2003). The turmeric (*Curcuma longa*) leaves, the unutilized part of turmeric plant, on hydro distillation yields oil rich in α-phellandrene (70%). This oil induces growth inhibition and larval mortality against *Spilosoma obliqua* (Agarwal *et al*., 1999). Insecticidal properties of several monoterpenoids to the housefly, red flour beetle and southern corn root-worm have been reported (Rice and Coats, 1994). Similarly, limonene found in the essential oil of various citrus leaves and fruit peels have exhibited significant insect control properties (Karr and Coats, 1988). Pulegone has also been observed to be more toxic than *l*-menthol against European corn borer, *Ostrinian ubilalis* (Hubner) 1st instar, where as reverse toxicity was observed against 2nd instar (Lee *et al*., 1999). These studies indicate that such compounds can make substantial impact as commercial products, if suitable delivery systems are developed. Beninger *et al*., (1993) has shown that diterpene 3-epicaryotin reduced growth of European corn borer larvae when incorporated into artificial diet and pupa deformities and time to pupation also increased. 1, 8 Cineole isolated from *Artemisia annua* is also a potential insecticidal allelochemical that could reduce the growth rate, food consumption and food utilization in some post harvest pests and house hold insects (Jacobson and Halber, 1947; Klocke *et al.,* 1989; Obeng and Reichmuth, 1997). Products isolated/derived from *Curcuma longa* (turmeric) and *Zingiber officinale* (ginger) have also been found effective as insect antifeedant and insect growth regulators (Agarwal *et al*., 2000; Agarwal and Walia, 2003). Thymol and carvacrol are definitely active against most fungal species tested (Kurita *et al.*, 1981; Muller-Riebau *et al*., 1995; Tsao, R and Zhou, 2000). The mechanism of action of these compounds against fungi is unknown but may be related to their general ability to dissolve or otherwise disrupt the integrity of cell walls and membranes (Isman and Machial, 2006).

The essential oil of *Melaleuca alternifolia* in concentration of 100, 250, 500 ppm has been found to be effective in decreasing local lesions of TMV on host plant *Nicotiana glutinosa* (Bishop, 1995). Another report has shown 62% inhibition against tobacco mosaic virus. The current Study is to search and explore Essential oils containing plants in various localities of Dir Khyber Pakhtunkhwa, which are being assessed for safety, economy, potency, productivity and availability in the area. Dir (**Figure 4**) is situated in the northern part of Pakistan. It is bounded on the north and north-west by the Chitral district and Afghanistan, on the east by Swat district, and on the south by Lower Dir district. Upper Dir is rugged and mountainous with peaks rising to 16,000 feet (4,900 m) in the north-east and to 10,000 ft (3,000 m), along the watersheds with Swat to the east. It is connected with the Kohistan District via the Badawi Pass.

The summer season is moderate and warm and June and July are hot months. Maximum and minimum temperature in June is about 33 and 16 degree centigrade respectively. During the months of December, January, and February, temperature normally falls below freezing point Maximum and minimum. The annual rainfall in Upper Dir is over 1,000 mm. Much of the area is covered by forest (Sadaf Javed: Rural Development Initiative Report Sep-October 2010). The study focuses various pests and insects which have devastating effects on productivity and life of important plants. Images taken from various sources and out sources are helpful for identifying bugs, beetles, and mites in the study area. The study may open a research gate for the production and quality of eco-friendly essential oils as green pesticides which can be used to minimize extinction and vulnerability of high valued medicinal plants, vegetables, crops and fruits in the near future.

Material and Methods

Several exploratory field visits were arranged from September 2012 to August 24, 2014. Two hot spot areas of Jaz banda and Katora Lake were also visited during summer (**Figure 5 (a and b)**). The ethno

botanical data was collected in local language (Pashto) according to the methodology suggested by (Schultes RE. 1962; Jain SK. 1989; Jain SK. 1995). Most visited places were Sheringal and Patrak (**Figure 6**). In the study, 19 knowledgeable elders' men (between the ages of 30 to 80) have chosen. All information provided by each informant was screened and confirmed through scientific literature survey for reliable data collection. Only authentic data was compiled and doubtful data was discarded. The plants possessing essential oils were collected, assigned code numbers and the field characters such as habit, habitat, color and odour of flowers, period of flowering and fruiting, occurrence and other relevant ecological features. All the collected plant species were dried and the herbarium specimens were prepared by using standard methods as suggested by (Jain SK and Rao RR, 1976). Taxonomical confirmation was made by renowned Prof. Dr. Jehandar Shah (Ex. Vice Chancellor Shaheed Benazir Bhutto University Sheringal Upper Dir Khyber Pakhtunkhwa. The specimen and voucher numbers of explored plants in the study area were submitted to the Herbarium University of Malakand, Chakdara Khyber Pakhtunkhwa. Some important insects, pests were also collected from various crops and forests, for the purpose of co-relationship between plants and their pollinators or affecters. Later on these were preserved in 70% Alcohol for further confirmation and studies, in the Department of Zoology, Shaheed Benazir Bhutto University Sheringal. To facilitate the feeding insects and pests of the area, a vegetable garden (30 x 210 ft) and a maize crop (60 x 114 ft) were prepared. Watering to the fields was supplied from a local spring at Sheringal, while one vegetable crop of pumpkin was watered irregularly with waste water coming from the local community to assist growth of larvae.

Results and Discussion

Before survey, a review of 72 plants possessing potential for green pesticides was made through literature survey (**Table 5, Figure 1**). 10 field visits to 25various locations (**Table 2**) of Dir Khyber pakhtunkhwa (**Figure 4**) were arranged. 25 plants species belonging to 07 families were explored (**Table 3**) which is 34.72% of the world explored species (**Figure 3**). The survey revealed 10 species from Lamiaceae (76.9%), 05 each from Asteraceae and Chenopodiaceae while 02 from Cupressaceae and 01 each from Poaceae, Pinaceae and Apiaceae respectively (**Figure 2**). The significance of this exploration is that all explored species have proven scientific record of insecticidal, bactericidal, fungicidal, viricidal or pesticidal activities and 12 explored plants are abundantly available for large scale production of green pesticides (**Table 4**). *Rosmarinus officinale* (An exogenic European spp) was also explored and included in the list of 25 explored plants. 10 Pests and insects (**Table 1**) that impact the crops, cereals; medicinal plants and trees were also explored in various locations of Dir Khyber Pakhtunkhwa. Some borers and pests were found during light rain and after sunset. The majority of them were feeding on cereal and vegetable plants. Corn-borer confined to maize crops, was found to feed on cultivated vegetables like egg-plant, potato, spinach, raddish, turnip, pumpkin, tomato, bean, *Nigella sativa*, and Lettuce. Breeding of insects and nourishment of larvae was extremely high in the pumpkin crop due to waste water channel, which impacted the surrounding crops, too. It was found that some fruit trees were affected by fungi, virus and rodents. The trees included Persimmon, Pear, Peach, Plum, Apple, Berries and Mulberry whereas some wild and cultivated plants and trees like *Polygonatum, Datura mentle, C*annabis sativa, *Piper longum* were not impacted. Cultivated trees from the wild that included of *Pinus roxburgii, Pinus willichiana, Picea smithiana, Cedrus deodara, Juglans regia* were also not affected by fungi, virus, insects and pests. It clearly indicates the presence of insecticidal and pesticidal constituents in these trees.

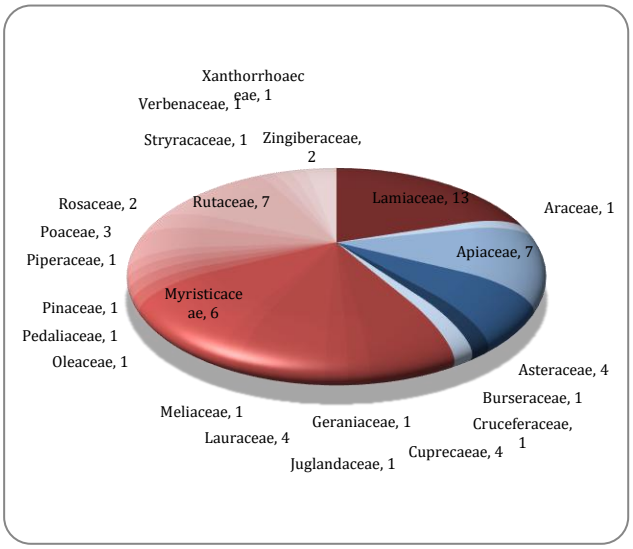

Figure 1 Family-wise distribution chart of Green pesticides in the world

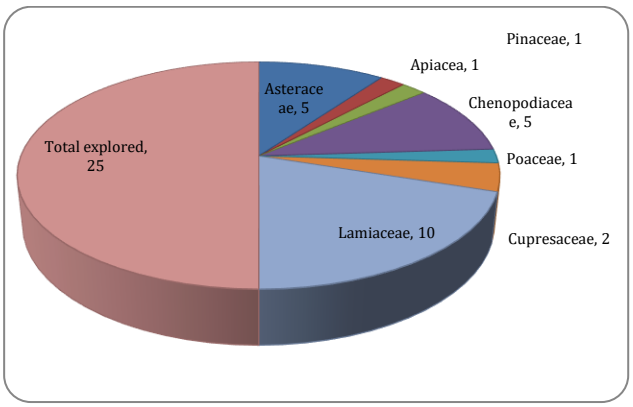

Figure 2 Family-wise Distribution of Green pesticides in Dir Khyber Pakhtunkhwa

Table 1 Explored Insects and Pests in Dir, Khyber Pakhtunkhwa

S. No.	Common Name	Scientific name	Authority
1.	American cockroach	*Periplaneta Americana*	(Linnaeus, 1758)
2.	Cowpea weevil or cowpea beetle	*Callosobruchus maculates*	(Fabricius, 1775)
3.	Common house mosquito	*Culex pipiens*	(Linnaeus, 1758)
4.	European corn borer	*Ostrinia nubilalis*	(Hubner, 1796)
5.	Common Housefly	*Musca domestica*	Linnaeus, 1758
6.	Wheat weevil or grain weevil or granary weevil	*Sitophilus granaries*	(Linnaeus, 1758)
7.	Pearly Underwing or Variegated Cutworm	*Peridroma saucia*	Hubner, 1808
8.	Jute Hairy Caterpillar or Bihar Hairy Caterpillar	*Spilosoma obliqua*	(Walker, 1855)
9.	Western Cornroot worm	*Diabrotica virgifera vergifera*	LeConte, 1868
10.	Codling Moth Larva	*Cydia poponella*	(Linnaeus, 1758)

Table 2 Explored locations in Dir Khyber Pakhtunkhwa

S. No.	Location	Latitude	Longitude
1.	Dherai Talash Lower Dir Khyber Pakhtunkhwa	34^{0}76'26" N	71^{0}86'15" E
2.	Thall Upper Dir Khyber Pakhtunkhwa	32^{0}21'50" N	70^{0}32'58" E
3.	Ziarat Talash Lower Dir	34^{0}74'15" N	71^{0}87'19" E
4.	Asbanr Dir Khyber Pakhtunkhwa	34^{0}80'20" N	72^{0}15'89" E
5.	Ayagay Dir Upper Khyber Pakhtunkhwa	35^{0}26'66" N	71^{0}93'33" E
6.	Barwa Khyber Pakhtunkhwa	34^{0}94'99" N	71^{0}68'33" E
7.	Barawal banda Khyber Pakhtunkhwa	35^{0}90'8" N	71^{0}75'90" E
8.	Biar Khyber Pakhtunkhwa	35^{0}36'66" N	72^{0}13'33" E
9.	Maina Doag (Lar Doag) Khyber Pakhtunkhwa	35^{0}34'54" N	71^{0}96'56" E
10.	Doag dara Khyber Pakhtunkhwa	35^{0}37'72" N	71^{0}95'26" E
11.	Maidan khwar Khyber Pakhtunkhwa	35^{0}51'9" N	71^{0}46'5" E
12.	Darikand Khyber Pakhtunkhwa	35^{0}45'9" N	71^{0}45'36" E
13.	Chakdara Lower Dir Khyber Pakhtunkhwa	34^{0}39'26" N	72^{0}2'7" E
14.	Chir Pai Banda Khyber Pakhtunkhwa	35^{0}17'8" N	72^{0}8'39" E
15.	Chutiatan Upper Dir Khyber Pakhtunkhwa	35^{0}14'87" N	71^{0}89'41" E
16.	Darora Upper Dir Khyber Pakhtunkhwa	35^{0}9'57" N	71^{0}9'90" E
17.	Lowarai Khyber Pakhtunkhwa	34^{0}39'26" N	71^{0}49'31" E
18.	Gujar Khyber Pakhtunkhwa	35^0 19'3" N	71^{0}49'46" E
19.	Warai Upper Dir Khyber Pakhtunkhwa	34^0 35'5" N	73^{0}3'20" E
20.	Timergara Lower Dir Khyber Pakhtunkhwa	34^0 82'80" N	71^{0}74'8" E
21.	Siasan Khyber Pakhtunkhwa	35^0 22'51" N	72^{0}5'15" E
22.	Shontala Khyber Pakhtunkhwa	35^0 56'41" N	71^{0}38'33" E
23.	Sheringal Upper Dir Khyber Pakhtunkhwa	35^0 17'1" N	72^{0}2'9" E
24.	Shaltalu Khyber Pakhtunkhwa	35^0 3'27" N	71^{0}37'15" E
25.	Rokhan Khyber Pakhtunkhwa	35^0 13'43" N	71^{0}53'59" E

Table 3 Explored Plant species (Green Pesticides) from Dir Khyber Pakhtunkhwa

S. No	Plant Scientific Name	Family	Locations	Local Pashto Name
1.	*Artemesia annua L. (Artemesia vulgaris), Artemesia indica Roxb*	Asteraceae	Kalkot, Jandray	Tarkha
2.	*Artemesia laciniata Wildd*		Lowari Top, Jandray	Tarkha
3.	*Artemesia parviflora Roxb (Artemesia japonica Thunb var. parviflora Roxb, Pamp*		Panakot, Lowari Top, Patrak, Thal	Tarkha
4.	*Artemesia scoparia W & K.*		Dir, Kalkot	Jaukay
5.	*Tanacetum longifolium Wall*		Kalkot	Kach gulay
6.	*Bunium persicum Boiss Fedtsch*	Apiaceae	Patrak, Kalkot, Doag dara	Zankay
7.	*Cedrus deodara (Roxb. ex Lamb.) D. Don*	Pinaceae	Patrak, Kalkot, Siasan, Kulandi	Dira Ranzra
8.	*Chenopodium bortrys L.*	Chenopodiaceae	Dir, Ayagay, Barawal banda	Sarmay, Skha Bootay, Skha kharawa
9.	*Chenopodium album L.*		Upto Kalkot	Sarmay
10.	*Chenopodium ambrosioides L.*		Dir Patrak	Skha Bootay

11.	*Chenopodium foliosum (Moench) Aschers*		Above Panakot	Skha Bootay
12.	*Chenopodium hybridum L.*		Thal, Lamuti	Skha Bootay
13.	*Cymbopogon stracheyi Raizada & Jain*	Poaceae	Dir, Panakot, Barawal banda	Wakha
14.	*Juniperus squamata Buch*	Cupressaceae	Shandur, Above Jazz Banda	Zangali Sarwa
15.	*Juniperus communis L(var. saxatilis Pall)*		Lowari Top	Zangali Sarwa
16.	*Mentha longifolia L. Huds (var. royleana BTh Rech.f.)*	Lamiaceae	Kalkot, Thall	Poodina, Eelanay, Veelanay
17.	*Mentha longifolia L Huds (var. incana Willd Rech.f. Dinsm)*		Dir	Veelanay
18.	*Nepeta cataria L.*		Miana	Zangali Gul
19.	*Nepeta clarkei Hk.f.*		Thall, Lamuti	Zangali Gul
20.	*Nepeta discolor Bth.*		Lowari Top	Zangali Gul
21.	*Nepeta elleptica Royle*		Patrak, Nirga	Zangali Gul
22.	*Nepeta podostach Bth.*		Panakot	Zangali Gul
23.	*Nepeta raphanorhiza Bth.*		Dir, Barawal Banda	Zangali Gul
24.	*Rosemarinus officinalis*		Sheringal	Angriz Bootay
25.	*Thymus serphyllum L.*		Lowari Top, Dir	Zangali sperkay

Table 4 Explored Plant species (Green Pesticides) from Dir Khyber Pakhtunkhwa
Status (A=Abundant, V=Vulnerable, Rare=R)

S. No	Plant species	Local Name	Status
1.	*Artemesia annua L. (Artemesia vulgaris), Artemesia indica Roxb*	Tarkha	A
2.	*Artemesia laciniata Wildd*	Tarkha	A
3.	*Artemesia parviflora Roxb (Artemesia japonica Thunb var. parviflora Roxb, Pamp*	Tarkha	A
4.	*Artemesia scoparia W & K.*	Jaukay	A
5.	*Tanacetum longifolium Wall*	Kach gulay	R
6.	*Bunium persicum Boiss Fedtsch*	Zankay	R
7.	*Cedrus deodara (Roxb. ex Lamb.) D.Don*	Dira Ranzra	V
8.	*Chenopodium bortrys L.*	Sarmay, Skha Bootay, Skha kharawa	A
9.	*Chenopodium album L.*	Sarmay	A
10.	*Chenopodium ambrosioides L.*	Skha Bootay	A
11.	*Chenopodium foliosum (Moench) Aschers*	Skha Bootay	A
12.	*Chenopodium hybridum L.*	Skha Bootay	A
13.	*Cymbopogon stracheyi Raizada & Jain*	Wakha	A
14.	*Juniperus squamata Buch*	Zangali Sarwa	V
15.	*Juniperus communis L(var. saxatilis Pall)*	Zangali Sarwa	V
16.	*Mentha longifolia L. Huds (var. royleana BTh Rech.f.)*	Poodina, Eelanay, Veelanay	A
17.	*Mentha longifolia L Huds (var. incana Willd Rech.f. Dinsm)*	Veelanay	A
18.	*Nepeta cataria L.*	Zangali Gul	R
19.	*Nepeta clarkei Hk.f.*	Zangali Gul	R
20.	*Nepeta discolor Bth.*	Zangali Gul	R
21.	*Nepeta elleptica Royle*	Zangali Gul	R
22.	*Nepeta podostach Bth.*	Zangali Gul	R
23.	*Nepeta raphanorhiza Bth.*	Zangali Gul	R
24.	*Rosemarinus officinalis*	Angriz Bootay	R
25.	*Thymus serphyllum L.*	Zangali sperkay	R

Table 5 World-wide plant species with known pesticidal activities

S. No.	Plant	S. No.	Plant	S. No.	Plant
1	*Acorus calamus*	25	*Citrus paradisi*	49	*Juniperus communis*
2	*Aloe aristata*	26	*Citrus sinensis*	50	*Juniperus virginiana*
3	*Anethum sowa*	27	*Commiphora myrrha*	51	*Laurus nobilis*
4	*Angelica archangelica*	28	*Coriandrum sativum*	52	*Lavandula angustifolia*
5	*Anthemis nobilis*	29	*Cuminum cyminum*	53	*Lavandula intermedia*
6	*Artemisia absinthium*	30	*Cupressuss empervirens*	54	*Lippia citriodora*
7	*Artemisia vulgaris*	31	*Cymbopogon citratus*	55	*Melaleuca cajuputi*

8	*Atremisia dracunculus*	32	*Cymbopogon martini*	56	*Melaleuca viridiflora*
9	*Azadirachta indica*	33	*Cymbopogon nardus*	57	*Melissa officinalis*
10	*Betula alba*	34	*Daucus carota*	58	*Mentha piperita*
11	*Boswellia carteri*	35	*Elettaria cardomomum*	59	*Mentha pulegium*
12	*Brassica nigra*	36	*Eucalyptus globules*	60	*Mentha spicata*
13	*Calendula arvensis*	37	*Eugenia caryophyllata*	61	*Myristica fragrans*
14	*Carthamus tinctorius*	38	*Foeniculum vulgare*	62	*Ocimum basilicum*
15	*Carum carvi*	39	*Helianthus anuus*	63	*Origanum marjorana*
16	*Chenopodium ambrosioides*	40	*Hyssopus officinalis*	64	*Juglans regia*
17	*Cinnamomum Camphora*	41	*Jasminum gradiflora*	65	*Tanacetum vulgare*
18	*Cinnamomum aromaticum*	42	*Origanumvulgare*	66	*Salvia sclarea*
19	*Cinnamomum zeylanicum*	43	*Pelargonium odorantissimum*	67	*Sesamum indicum*
20	*Citrus aurantifolia*	44	*Pimenta dioica*	68	*Styrex benzoin*
21	*Citrus aurantium*	45	*Pimpinella anisum*	69	*Thuja occidentalis*
22	*Pogostemon patchouli*	46	*Pinus sylvestris*	70	Yarrow
23	*Rosmarinus officinalis*	47	*Piper nigrum*	71	*Zingiberaceae officinale*
24	*Ruta graveolens*	48	*Prunus amygdalus*	72	*Rosa damascene*

Table 6 List of Biopesticidal commercial Brands in Ohio State University 2010, USA
(Source: Biopesticide Controls of Plant Diseases: Resources and Products for Farmers in Ohio- Page 7)

S. No.	Trade Name	Ingredient	Manufacturer	Target Crop	Target Disease
1.	Garlic Barrier®	Garlic oil	Garlic Research Labs, Inc.	Cocurbit, forage, fruiting vegetables, herbs, leafy vegetables, Kiwi, Legume vegetables, Nut trees, Ornamentals, Peanuts, Pome fruite trees, Root & Tuber vegetables, Berries, Sugarcane, Sunflower, Tropical fruits, Turf grass	Brown spot, Insect Infestation
2.	Green Light® Neem Concentrate	Neem oil	Green Light Company	Vegetables, fruits, nuts, and spices	Powdery mildew rust, anthracnose, leaf spot, and other diseases
3.	ECO E-RASE®	Jojoba oil	IJO Products, LLC	Garden and commercial vegetables and crops	Powdery mildew and Whitefly
4.	Heads Up® Plant Protectant	Extract of Chenopodium quinoa saponins	Heads Up Plant Protectants	Soybeans, Potato, Tomato, Peas, beans and wheat	Soil born plant root rot, and damping-off disease
5.	Promax™	Thyme oil	Bio HumG Netus, Inc.	Crops, Ornamental Plants, and turf	

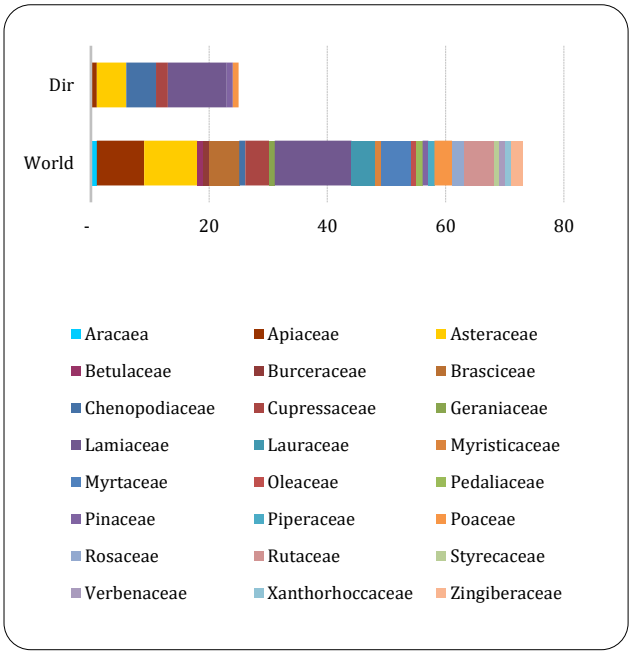

Figure 3 Family-wise Species Comparative Distribution of World with Dir Khyber Pakhtunkhwa

Figure 4 Map of District Dir Upper, Khyber Pakhtunkhwa (Source: SadafJaved: Rural Development Initiative Report Sep-October 2010)

Figure 5 (a) Photos of Jaz Banda (at 10300 ft)

Figure 5 (b) Katoralake (Ref: www.pakwheels.com)

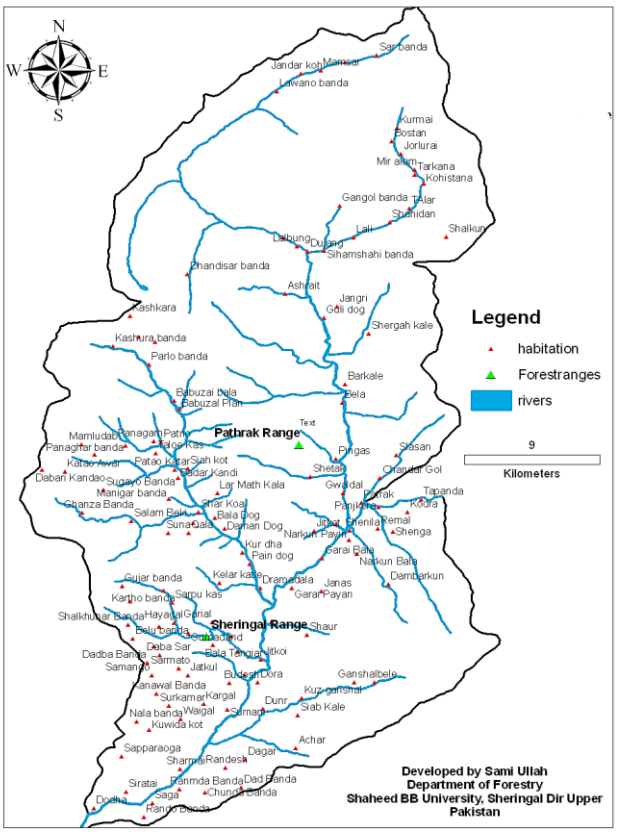

Figure 6: Map of Sheringal and Patrak 2014 ranges of DirKohistan along with villages, developed and processed by SamiUllahDawar, Ph. D Scholar, Freiburg, Baden-Wurttemburg Germany)

Conclusions

Pesticides based on plant essential oils or their constituents have demonstrated efficacy against a range of stored product pests, domestic pests, blood feeding pests and certain soft-bodied agricultural pests, as well as against some plant pathogenic fungi responsible for pre- and post-harvest diseases. It is concluded that the study area is rich in essential oils containing plants study area, including those which were not probed before for pesticidal activities. Their formulated extracts may be applied as fumigants, granular formulations or direct sprays with a range of effects from lethal toxicity to repellence and/or ovipositor deterrence in insects. In western societies, biopesticidal brands are available (**Table 6**). Due to their volatile nature, there is a much lower level of risk to the environment than with current synthetic pesticides. Predator, parasitoid and pollinator insect populations will be less impacted because of the minimal residual activity, making essential-oil-based pesticides compatible with integrated pest management programs. It is expected that these pesticides will find their greatest commercial application in urban pest control, public health, veterinary health, vector control vis-à-vis human health and in protection of stored commodities. It is also concluded that researchers on flora and fauna should expand the exploratory procedures on the basis of temperature, humidity, soil condition, pH, water sources and precipitation, too. Similarly, it is also necessary to estimate insect and pest resistance to biopesticidal constituents at the pre-formulation level. The study suggested change of habitat by local pests and insects as well as adaptation strength among insects and pests to the change in climate and environment which is a breakthrough in the diversity of natural habitat. Climatic changes may not only alter the essential components in terms of quality or quantity but is also responsible for the survival of the fittest among pests, insects and butterflies. Those essential oils which are sensitive to environmental or climatic change may also modify the life cycle of insects and pests. A plant showing repellant activity may explicit attractant activity in the coming days. It clearly enumerates new windows of research for biologist of the current time. Also coming of new varieties and species both in flora and fauna through inter and intra-habitat interaction itself is an opened research field. The study revealed two hypotheses for green-pesticides use and over-use. (i) Insects like butterflies responsible for pollination may get affected with over usage of pesticides. (ii) Life-cycle and population of flies which are responsible for natural decontamination may get a negative impact in the long run. Therefore, preformulation studies must be carried out, before production for massive use and application. Further research in the field of biopesticidal should be multi-dynamic and mere eradication of pests and insects must be avoided as both plant and vectors are responsible for important biodegradable products for a healthy and ecofriendly environment. The results of the study promises procedure for the protection of

vulnerable and endangered plant species. Therefore, ex-situ cultivation of green pesticides which are rare and endangered must be the prime focus in order to produce valuable and safe biopesticides& insecticides on large scale.

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