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Comparative Studies on Quantity and Quality of Pests' Incursion Sugarcane grown at Rahim Yar Khan Pakistan

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Abstract

Sugarcane is a vital crop worldwide well-known for many nutritious and economic uses. This study was designed to evaluate the association between sugar cane plantation and pest infestation to crop in relation to abiotic factors (temperature, relative humidity and rainfall) in tehsil Khan Pur district Rahim Yar khan from April 1 to July 30, 2019.These abiotic parameters whether have any impact on population density or not was checked. Generally cane varieties grown the Rahim yar khan are, In Pakistan, sugarcane was cultivated on 1313 thousand hectares area in 2017-18. During the last few years the average area under cultivation has increased while the average production of sugarcane falls between the ranges of 45-50 tons/hectare. Insect and pests had been reported playing havoc and main role in reducing the yield of sugarcane. The most serious insect pests limiting sugarcane production are sugarcane borers, stem borers, guard spur borer and Pyrilla. These insects pests potentially caused reduction in the sugarcane production from 15-20, 10-20 and 30-35 percent respectively. In past, chemical control of the pest was in regular practice and it was recommended for tackling these pests. However, Integrated Pest Management technique and biological control has been developed in which the hazards of chemicals is either avoided or reduced to a minimum. Entomology laboratory, which prepares Trichogramma chilonis and Chrysoperla cards bearing the eggs of these insects provided to farmers to use them in their sugarcane fields. Top borer Scirpophaga nivella (Crambidae), shoot borer and stalk borer are found pre-dominantly in sub-tropical areas whereas internodes borer and early shoot borer are prevalent in tropical region. Lepidopteran stalk borers are the main pests that severely damage sugarcane in many sugarcane producing countries. The losses in sugarcane from insect attack affect both yield and sugar recovery. After hatching of the eggs of these useful insects larvae and adults feed on eggs of harmful borers as biological control. Many insect pests damage the crop throughout the season from germination to harvest. The losses in sugarcane from insect attack affect both yield and sugar recovery. These results indicate that sugar cane production/yield is directly or indirectly related to pest fluctuation at the study site. The role of different abiotic parameters are also core issues leading to pest dynamics. Regression analysis revealed significant ($P<0.05$) differences as a result of pest infestation on sugarcane crop.

Keywords: Insects; Pests; Sugarcane; Stalk borer and insect population; *Pyrilla perpusilla;* Abiotic factors

Introduction

International travel, world trade and change in meteorological conditions increase the perils from pest and disease incursions and outbreaks in many agricultural systems. Pakistan is situated in a subtropical arid zone and is located between latitudes of 240 and 370 N° and longitudes of 610 to 750 °E [1]. The country's economy remains heavily dependent on agriculture not only for food supply but also as a source of raw material for agro-industries and as a source of employment. Lepidopteran stalk borers are the chief pests that strictly damage sugarcane in main sugarcane producing countries. Larvae bore either into the shoots or stalks of sugarcane, harshly reducing both yield and sugar content [2-5].The sugarcane crop possesses an incredible potential for the production of a wide range of carbon-chain molecules, higher proportion of lignin, cellulose and hemicelluloses than any other C4 crops, such as sorghum and maize [6].Today multi-usage crop helping a variety of segments like food and pharmaceuticals to energy production. Recent advances in industrial biotechnology are providing new opportunities to capture additional revenue streams from bioproducts (e.g. bioplastics) using sugarcane stalks and residues ('bagasse') as energy feedstock [7]. Sugarcane is an important industrial and cash crop in Pakistan and in many countries of the world. . Sugarcane is grown in many countries

worldwide and is known to host more than 1500 insects and 80 diseases, but the vast majority have restricted geographic distributions. However, the compliance of some pests and their infiltration into sugarcane areas can be amazing and very costly. Average production of sugar cane in Pakistan is 450 - 500 maunds per acre which is very much low compared to the cane production by other countries. The factors effecting its production are agronomic factors comprising of preparatory tillage, bed preparation, planting techniques and time, water availability for irrigation, application of fertilizers, management of ratoon crop, harvesting time, type of cultivars and plant protection measures meaningfully affect its production followed by cost of production. Products like sugar, Panela (Jaggery, gur), alcohol, ethanol, bagasse, paper making and chip board manufacturer and soil fertility as enriched source of organic matter after cane is crushed. Pakistan conquers a significant position in cane producing countries of the world and ranked fifth position in cane acreage and production and almost 15th position in sugar production. Around more than 1500 species of insects feed on sugarcane plant recorded throughout the world [8]. Sugarcane is specially grown in tropical and sub-tropical regions of the world in a range of climates from hot dry environment near sea level to cool and moist environment at higher elevations irrigated with moderate temperature frost free zone between 26° N latitude to 30°N latitude, Irrigated arid sub-tropical zone between 240° N latitude to 260° N latitude, Temperate zone of northern Punjab and K.P.K. between 32° N latitude to34° N latitude. A comprehensive list of about 800 records of parasitoids, predators and pathogens of the 24 key moth borers in Asia and the Indian Ocean islands was complied, with enormous information on the host stage they attack, host plant or crop and country of record [9]. A report documented 48 species from Indo-Pakistan subcontinent feed on crop [10]. Many important insect's pests have been stated even from Pakistan [11] and province of Sindh [12]. Amongst them, borers and leafhoppers are major devastators reduce the quality and quantity of cane and cane sugar. Biological control for sugarcane crop is extensively being used in different parts of the world like South America, Brazil, the tachinid larval parasitoids, *Metagonistylum minense* (Tns.) and *Paratheresia claripalpis* (Wulp.) and the braconid *Cotesia flavipes* (Cameron) have been in practice since long. Subsequently 1988, parasitoid releases reduced infestation level from 10% to an average and in 1994 about 3% [13]. Sugarcane can be grown on a variety of soil conditions with a greater success like clay loams and heavy alluvial soils are amongst the best, with top soil surface holds high moisture retaining capacity while sub soil should be porous and well drained. (Khoso). Two planting seasons like Rabi and fall in September - November and spring sowing in February - March. Fall planting starts from the first week of September and continuous to mid-October in the Punjab and Sindh provinces, while in the KPK. Planting is completed in October and November. Spring planting starts from mid-February and lasts until the end of March in the Punjab and Sindh. These planting times are strictly observed which might reduce the yield about 30%. Lack of appropriate selection of seed rate and spacing contribute low output in the field. Others factors contributing the low production of sugarcane crop comprising of common weeds are *Euphorbia* reduction in yield. The most serious insect pests are sugarcane top borer, stem borer, Gurdaspur borer, and army worm, white ant (feeding inside the cane and causes less germination). *Pyrilla* (*Pyrilla* is the most destructive foliage sucking pest); whitefly, mealy bug and black bugs are also causing damage causing yield reduction from 10-35% according the pest attack and in some cases it may range from 80-85 percent subsequently leading to yield reduction as a result of heavy pest attack. Normally harvesting practice is completed upon crop maturity followed by early harvesting of ratoon crops. Consequently, harvested cane should be immediately heaved to the mill to reduce weight and sucrose losses.

In Pakistan the reason for the low production of sugarcane is aptly related to poor soil fertility, low seed rate, seed quality is poor, conventional sowing methods are obsolete and shabby agro management. [14] and [15] laid stress on low cane intrinsically and acclimatization play a major role. [16] adopted better techniques and high yield different breeding techniques of sugarcane production are improved. Of the various reasons, attack of insects and pests has significant contribution in limiting sugarcane production. For instance, borers, growth and sucrose level and amplification of the fiber level and Similarly, Stem bores practically as a source of injury thus feeding on internal tissues a probable root cause of low production and overall yield [17]. In Pakistan a massive loss of sugarcane production pertinent to insect's pest's outbreak has been reported by [18]. Early shoot borer or shoot borer, *Chilo infuscutellus* (Pyralidae: Lepidoptera) is a wide spread pest in all sugarcane growing areas of the country and Indian Punjab, UP with its peak activity during May June [19]. According to [20] sugarcane production India has faced annually loss of about Rs 8.6 million due to the pest insects and [21] stated that average production of sugarcane around the world is about 170 million tons and Brazil is the leading producer of sugarcane with 33 million tons of production. According to the global ranking in terms of sugarcane production, Brazil stands first with 39% of the total sugarcane production followed by is India with 19% cultivation while Pakistan, China and Thailand each contribute 7% in terms of sugarcane production [22].The sugarcane is effected by harmful pests. Proper protection of cane from the harmful pests can be minimized by IPM program which are scientifically designed during the year. In IPM program the pesticides are playing an important role. The farmer usually used insecticides application for the control of insects. In Pakistan the insects attack are decreasing the yield of the cane, but it is estimated that *Pyrilla*, top borers and Gurdpur borer are the main cause of reduction in yield is 15-20,10-20 and 30-35% respectively. Which is in the however, in a few cases the high from 80-85 percent are decreased in the yield of crop, which is reported due to the attack of insects. [23, 24] stated that insect's herbivores were creating the greatest

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threats in the production of agriculture in worldwide. Moreover, crops planted towards the end of the dry season in Papua New Guinea tended to be more heavily attacked by *Sesamia grisescens*, so this practice is now avoided. [25] stated that the whitefly of sugarcane is one the important pest. The control of whitefly were done chemically and biologically in the integrated management program. Early harvesting and balanced fertilization has reduced the impact of *E. saccharina* on sugarcane in South Africa [26]. The aim if the current study to understand the pest dynamics of economically important crop of sugarcane.

Figure 1: Collection of spectrum of Economic pests of cane crop.

Materials and Methods

Location Survey and assessment of pest complex

Assessment was started from June 2018 to February 2019 and HSF 242 variety of sugarcane predominantly cultivated in this district. Pest species complex and their relative richness were assessed by plant sampling. The district Rahim Yar Khan was selected for this study with four tehsils comprising of Sadiqabad, Rahim Yar Khan, Khan Pur and Liaquat Pur. This study was conducted in a randomly selected Tehsil Khan Pur. Khan Pur is much renowned for sugarcane cultivations. 28 of the 10 villages along with union councils randomly selected for study. Interviews schedule was used as data collection tool. All these sites were personally visited for the infestation of sugarcane crop and collection of pests were made possible direct from the field (Figure 1).

Collection of spectrum of Economic pests of cane crop

Diverse pests were collected from the tehsil Kanpur from different sites/locations of sugarcane crops. This survey is in progress with the onset of different seasons. The collection was made possible right from the seasoning time till maturity of the crop and providing a comprehensive data collection to assess their damage in a real way. To determine insect pests composition in Sugarcane pests hence collected with a wide range of insects including major groups like, Leaf feeders (Lepidoptera, *Noctuidae*) and grasshoppers/locusts *(Orthoptera)*, sap feeders, stalk feeders and root feeders.

Identification of collected pests

Subsequently different pests hence collected from the sugarcane crop identified using different keys and other entomological sources from the literature. Also specimens were sent to Jhang entomological Sugar mill for the exact identification.

Estimation of sugarcane yield loss after incursion of pests

The area under survey was assessed for pests' infestation and work on the crop yield was evaluated before and after pests infestations to get an idea of total productivity. The yield loss was calculated by the following formula,

Sugar yield loss = Loss in pest incursion plot – loss in non pest incursion plot

Insect pest incidence

Incidence of shoot borer was estimated using the following formula:

Incidence of stalk borers was determine based on the number of the number of bored stalks over the total stalk population as,

Investigation of metrological parameters

The meteorological data collected from respective meteorological office regarding relative humidity (RH %), Rainfall, wind pressure and atmospheric temperature to analyze the impact of such parameters on pest population and their fluctuation/ outbreak followed by impact on the cane crop.

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Socioeconomic status of masses related to sugarcane growers

The socioeconomic impact will be assessed as a result of sugarcane marketing and age group involved in sugarcane business and poverty alleviation there in. How much this socioeconomic impact whether improved the living standard and ameliorated their life style or not was discussed through questionnaires?

Statistical analysis

Date regarding pests and associated damage will be statistically analyzed using the software Minitab version 19 to understand significance at ($P<0.05$) level.

Results

Insect Pests Composition

Leaf feeders include pest like *Chlio infesticallus* (Lepidoptera, *Noctuidae*) as early shoot borer: outbreaks the crop during the early part of cane growth, before internode formation and grasshoppers/ locusts *(Orthoptera: Acrididae).* Such pest dynamics is erratic in nature and certain species cause sporadic outbursts [27]. Rigorous use of mechanical harvesting and the use of weary blankets along the sugarcane rows can provoke pest eruptions. This pest *Chlio infesticallus* is mainly destructive to the newer plants. The damage is done by the caterpillars which bores into the stem and feed the soft tissues. While feeding the caterpillars moves in ascending as well as descending order may effect roots. Similarly, damaging the central shoot, devoid of juices and making cane hard become hard to mill. Tunnels in shoot may also effect both quality and quantity of the juice is shortened.

Sap feeders are mostly Hemipteran species, including White fly *Neomaskellia bergii* (Aleyrodidae*)*. Its Status is minor and sporadic, *Saccharum officinarum, S. sinensis, Bambusa sp., Cenchrus ciliaris, Panicum maximum, Paspalum conjugatum, Pennisetum purpureum. Setaria chevaliera, S. italica, Sorghum caudatum, S. halepense, and S. vulgare.* Adults are sluggish with brownish patterns on forewings. Eggs are yellowish, laid in characteristic, concentric, opposite semicircles. Nymphs are brownish, *Coreus mariginates* (Coreidae). The head, pronotum and abdomen of an adult bug are spotted reddish brown. Sexual dimorphism is documented and males are smaller than female. Directly feeding on the plant sap is constituted by some species being known disease vectors of sugarcane [28]. These pests are multicultural so the maintenance of strict quarantine actions is needed to ensure protection against these major diseases.

Stalk feeders can be loosely categorized depending on the time of invasion and the feeding site into top feeders, stem feeders and shoot feeders. Moth borers predominate and are by far the most damaging sugarcane pests in all cane growing countries, except Australia and Fiji [29]. About 50 species of moths in the genera *Chilo, Eldana, Sesamia, Diatraea, Scirpophaga, Eoreuma, Tetramoera and Acigona* that attack sugarcane worldwide (Long& Hensley 1972). Numerous are polyphagous readily attacking other gramineous crops (maize, rice, millet, and sorghum) and wild grasses [30] providing pest sanctuaries confusing crop-pest connections. Larval injury reduces biomass and sugar content [31]. Moth borers are problematic to control because their larvae are unapproachable inside the cane. Therefore, biological control is recommended.

Root feeders are mainly white grub *Holotrichia serrata* (Coleoptera: *Scarabaeidae*) is an important soil pest of sugarcane in tropical areas major source of plant drying and increased danger of the canes failure. Members of the subfamilies Dysnatinae, Rutelinae and Melolonthinae, the most damaging genera are *Hoplochelus, Dermolepida, Lepidotia, Heteronychus, Adoretus as* repored by [32]. Other pests include termites specially two species *Odontotermes obesus* and *Microtermes obesi* and leaf beetles comprising of *Coccinella septempunctata* and Convergent lady beetle *Heppodamia convergens.* Within the sugarcane agro system, there is also an innumerable of predatory arthropods (e.g. spiders and ants) and other beneficial organisms like *Tricogramma japonicum* and *Tricogramma chilonis* (isshi) playing a major beneficial role in pest suppression [33,34]. Parasitoid wasps such as *Trichogramma* spp. provide an effective control of eggs and larvae of stem borers [35, 36].

Groups of pests order dynamics in sugarcane crop

Hemiptera

Its White fly *Neomaskellia bergii* and widespread in Asia, Africa, Oceania, Fiji, French Polynesia. Hosts plants are Sugarcane, bamboo, and several sorghum and grass species.it belongs to class Insecta: Hemiptera: Sternorrhyncha: Aleyrodidae, and its Status is minor and sporadic, *Saccharum officinarum, S. sinensis, Bambusa sp., Cenchrus ciliaris, Panicum maximum, Paspalum conjugatum, Pennisetum purpureum. Setaria chevaliera, S. italica, Sorghum caudatum, S. halepense, and S. vulgare.* Adults are sluggish with brownish patterns on forewings. Eggs are yellowish, laid in characteristic, concentric, opposite semicircles. Nymphs are brownish*. Coreus marinates: Suborder Heteroptera*, 42,300 described species, Phytophagous, Insects of the heteropteran super families Coreoidea and Lygaeoidea are reliably associated with symbionts, It occurs throughout Europe, Asia and northern Africa. It's from Family Coreidae a large and mottled reddish-brown squash bug, broad, oval abdomen. Two small antennae are diagnostic. (Figure 2) (Table 1).

Coleoptera

The white grub *Holotrichia serrata (Coleoptera: Scarabaeidae)* is an important soil pest of sugarcane in tropical areas. Through inconspicuous late larval feeding activity, *H. serrata* has the potential to cause complete loss in sugarcane crop. Sugarcane crop is infested with more than 200 species of pests. Among the pests, the subterranean white grub has potential to cause 80-100% damage to sugarcane crop. White grubs *(Coleoptera:*

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Scarabaeidae) soil inhabiting, root feeding immature stages of scarab beetles. The white grub Scarabaeidae is the second largest and omnipresent family within the order Coleoptera. White grubs being serious pests of most agricultural crops, fruits, vegetables, ornamental plants, plantation crops, pastures, turf and meadow grasses, lawns, golf courses and forest trees in different part of the world. Chemical control measures are ineffective since the pests are subterranean. The grey back cane grub *(Coleoptera: Dermolepida albohirtum)* is the most damaging sugarcane pest in Australia, with estimated annual losses of up to $10 million and with periodic outbreaks where losses may reach $40 million in damage and management expenses. Understanding the biology and behavior of *D. albohirtum* is essential to achieving successful management. The population dynamics are directed by factors that include climatic condition soil types, pathogen levels, farming practices and pesticide use. There are numerous species of ladybird beetles, being aposematic coloration referred to as ladybugs/ *Coccinella septempunctata.* Noteworthy garden pests, strictly aphidophagous, all other ladybugs are the first line of defense for the home gardener against many soft-bodied pest insects. Grow flowering plants that produce the nectar and pollen eaten by adult lady beetles. Aphids, spider mites, scale insects, whiteflies, leaf beetle larvae, some insect eggs and small caterpillars. This is especially significant in late spring before the insects they feed on become plentiful. More than 47 species of natural enemies of the sugarcane aphid have been identified worldwide. Sugarcane beetles especially *Eutheola rugiceps* is recorded as pests of many other plant species, including sugarcane, corn, wild grasses, *eucalyptus* , rice, roses, strawberries, tobacco, potato, and sweet potato. This polyphagous feeding performance rises the difficulty of envisaging sugarcane beetle outbreaks because they are able to survive and reproduce on plants commonly found across systems. Damage in sugarcane and corn is similar (Figure 2) (Table 1).

Arachnida

The sac spiders *Clubiona drassoddes* of the family Clubionidae: Arachnida have a very mystifying taxonomic history. Once, this family was a large catch-all taxon for a dissimilar collection of spiders, similar only in that they had eight eyes arranged in two rows and conical anterior spinnerets that touched, and were wandering predators that built silken retreats, or sacs, usually on plant terminals, between leaves, under bark, or under rocks (Figure 2)(Table1).

Table 1: Meteorological data regarding abiotic factors influencing pests infecting sugarcane crop.

Months	RH%		Temperature (C°)		Rainfall (mm)	Wind speed (Knot)		Pest Dominance and Incursion
	3am	12pm	Max	Min		3am	12pm	
April	52	20	40.7	21.1	0	2	2.6	*Scirpophaga novella, Chilo infuscatellus, Dermolepida albohirtum, Green lacewing ,Fulmekiola serrata, Thomisus onustus, Eldana saccharina, leucopterus*
May	45	19	43	25.1	0	1.7	2.1	*Scirpophaga novella, , Chilo infuscatellus, Clubiona drassoddes, Chilo partellus, Malanoplus differentialis sp, Inopus rubriceps, Coreus mariganatus, Anisoptera libellulidae, Pyrilla perspilla , Neomaskellia bergii, Chilo auricilius, Hieroglyphus banian , Eldana saccharina,*
June	63	31	44.3	28.4	6.4	2.5	3.1	*Scirpophaga novella,Chilo infuscatellus, Holotrichia serrata,, Coccinella septempunctata, Heppodamia convergens, longed horned grasshopper Tettigonidae, Odontotermes obesus, Tricograma japonicum,*
July	70	43	41.4	28.6	14.1	1.9	1.8	*Bissetia steniellus, Scirpophaga novella termites, Eutheola rugiceps, Apis dorsata*

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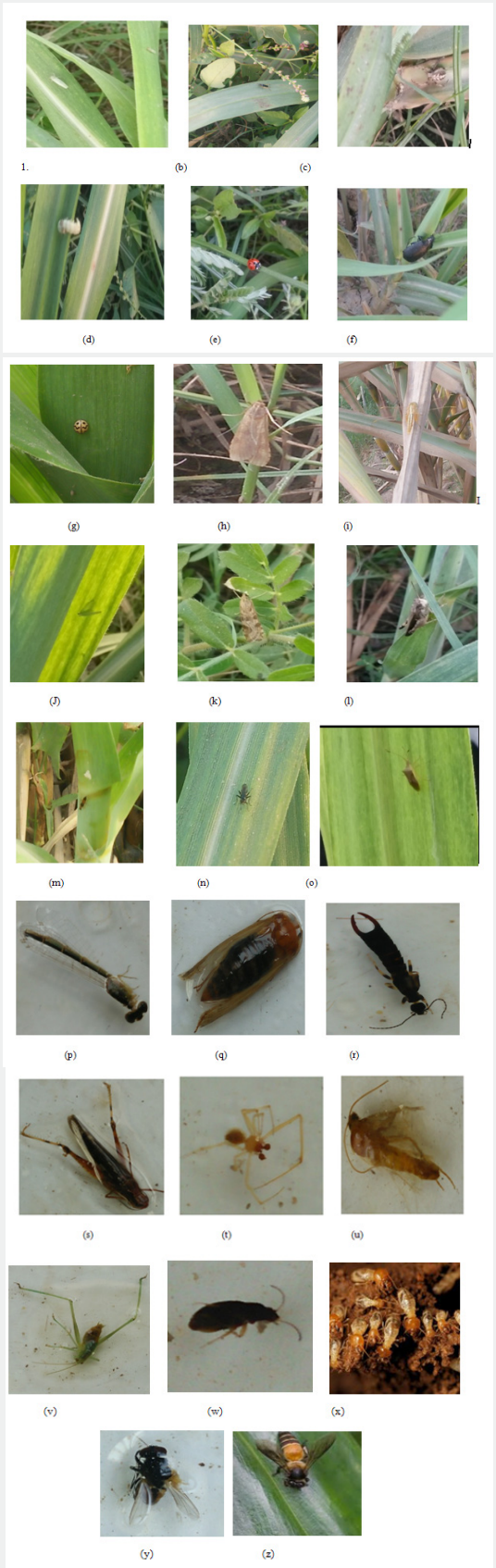

Figure 2: Number of pests observed in sugarcane crop at Rahim Yar Punjab Pakistan.

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Lepidoptera

This pest *Chlio infesticallus* is mainly damaging to the younger plants prevailing in Pakistan and India. The impairment is done by the caterpillars which bores into the stem and feed the soft tissues. While feeding the caterpillars moves ascending as well as descending and may influence the roots. They also damage the central shoot. Infestation of internode makes the matured cane hard, devoid of juice which becomes problematic to mill. Tunnels are also formed within the shoot as a result both quality and quantity of the juice is condensed. Impairment done by this pest may be up to 50%.12. The spotted stem borer *Chilo partellus* is an oligophagy and feeds on species of grasses, sedges, cultivated cereals, especially maize, sorghum, rice, sugarcane, and millets. It survives on several grasses including Sudan grass (Sorghum *vulgare sudanense*), Napier grass *(Pennisetum purpureum)*, and *Sorghum arundinaceous*. *Chilo partellus* (Swinhoe) Common name: Spotted stalk borer. Taxonomic placing: Insecta, Holometabola, Lepidoptera, and Crambidae. Geographical distribution: East and South Africa, The Middle East, India and Pakistan. *Chilo auricilius* (Pyrilidae) is pest of sugarcane causing decrease of production. Egg of *Chilo auricilius* survived from parasitoid of *Trichogramma*. Eggs usually hatch in the morning, 2 cm long of larva emerge, size captive of head is bigger than the body, the forewings of the adult variable, being yellowish or brownish with silvery dots, either scattered or arranged in two transverse bands. The fringe round the margin of the wings is golden yellow. The forewing length is 8 to 13 millimeters (0.3 to 0.5 in) and the width 3 to 4 millimeters (0.12 to 0.16 in). Hindwings pale brown (Table1).

Odonata

Dragonfly *Epiaeschna hero* (fabricus), Eyes blue and large, dark brown. This species is the largest .It is unusual, in that like, males don't defend or patrol territories. swarming in large numbers is well documented, feeding on flying insects at dusk, both high in the air or lower to the ground, such as over culverts. Females lay eggs in mud or vegetation, often some distance above the water line or in areas that will fill with water after heavy rains. Odonates are ecologically important as both predators and prey. Their larvae constitute a natural biological control over mosquito larvae and thus help to control several epidemic diseases like *malaria, dengue,* and *filaria*. The adults of some species visit and help in controlling insect pests. Females of all the species consume much greater number of insect pests as compared with male (Figure 2) (Table1).

Neuroptera

It's taxonomically placed in order Neuroptera. *Chrysoperla carnea* (Stephens) and *Chrysoperla rufilabris* (Burmeister) have wide commercial availability and use as biological control agents of *Bemisia tabaci*. *Chrysoperla rufilabris* is widely used in various situations to control many different pests. Many species of adult lacewings do not kill pest insects, they actually subsist on foods such as nectar, pollen and honeydew. It's their predacious offspring that get the job done. If you're looking for effective aphid control, green lacewing larva should help do the trick (Figure 2) (Table 1).

Orthoptera

The differential grasshopper is a severe pest of crops including small grains, corn, alfalfa, soybeans, cotton, various vegetables, and deciduous fruit trees. The nymphs attack small grains, alfalfa, and other hay crops. After they become adults and have destroyed these crops. Antenna short horned producing buzzing noise, stripes on its thighs, agricultural pest, and a dense swarm can destroy crops in 3-4 days. Among its host plants from several plant families, like Compositae appear to be the most important (Figure 2) (Table1).

Thysanoptera

The exotic oriental sugarcane thrips *Fulmekiola serrata* (Kobus) *(Thysanoptera: Thripidae)* causes grave and extensive damage to sugarcane crop. It causes direct damage to the foliage by its feeding and ovipisition behavior. Both adults and nymphs abolish the epidermal cells by piercing them with a single mandibular stylet and drinking the liquid content through paired maxillary stylets. Damage symptoms are malformation of young leaves and growing tips, wilting, silvering, scarring and necrotic spots that are caused on the leaf spindles and become apparent when the leaves open (Figure 2) (Table1).

Diptera

This fly Family *Stratiomyidae: Diptera* (Soldier flies) *Inopus rubriceps*: feed on grasses, and is a sugarcane pest in the Pakistan area. The distribution of the sugarcane soldier fly, *Inopus rubriceps* is mapped in Australia, introduced range, New Zealand and California. Populations are discontinuous, and apparently determined by warm temperatures (> 12.8 °C mean annual temperature) and high rainfall (>750 mm/yr. in warm temperate or > 1000 mm/yr. in subtropical/tropical regions) (Figure 2) (Table1).

Isoptera/Blattoidae

Odontotermes obesus (Rambur) is an extensive termite species in South Asia causing substantial losses annually .*Odontotermes,* commonly known as the fungus-growing termites, is a termite genus belonging to family Termitidae. These termites damage setts, shoots, canes as well as stubbles. Termite infestation occurs soon after planting and continues till harvest. They are most damaging in wooden homes, and are agricultural pests in the tropics and subtropics of Africa and Asia. For management flooding at the time of planting because it stops termite attack, burning of crop residue on top of termite mounds to suffocate the pests,destruction of termite affected setts from the field, and spraying on sugarcane setts, *Imidacloprid* and *chlorpyrifos*. (Figure 2) (Table1).

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Discussion

According to an approximation, sugarcane production deteriorations by 20-25% by insect pests. Sugarcane is infested by about more than 200 insects of which nearly one dozen causes heavy losses to the quality as well as quantity of the crop (Table 2). The losses in sugarcane from insect attack disturb both yield and sugar retrieval. *Chilo genus is the* major stalk borers which are extensively distributed in sugarcane planting fields in China, causing severe injury to the plant and easily communicated by vegetative propagation of sugarcane Huang [37,38]. Weather change could alter patterns of commotion from pest insects through direct effects on their development and survival, adaptation capability, availability of host plants and physiological changes in host defenses, and indirect effects from changes in the abundance of natural enemies, mutualists, and competitors [39]. In current years, the international climate warming and the exchange of sugarcane cultivars between different areas have led to variations in the species, incidence and extent of damage caused by yellow top borer *Chilo infuscatellus* in main cane-growing areas, for example, Guangxi, Yunnan, Guangdong, and Hainan in China [40]. The sugarcane beetle *Eutheola rugiceps* has also been reported as a pest of agronomic (Corn, rice, sugarcane) and specially, sweet potatoes, Strawberries, and turf grass principally in the southeastern United States.The invasion of sugarcane borers has become progressively severe causing excessive economic loss. It is therefore imperative to appropriately comprehend the effect of *Chilo infuscatellus* and spotted stalk borer *Chilo partellus* on sugarcane and sugar produce loss that they cause. Numerous preceding studies have shown that the species, their population structure and main population of sugarcane borers varied by planting field and growth period, and that could cause the different impacts on sugarcane production, and different loss of cane and sugar yield. Thus, studying and ascertaining the sugarcane yield and sugar yield loss under natural field conditions when pests happen in mixed populations is important. It can provide detailed data and contribute to effective control and damage in the main sugarcane production area. These results are consistent with previous studies on other borers for e*xample Chilo sacchariphagus* and *Scirpophaga excerptalis* , *Diatraea saccharalis* [41-43], *Eoreuma loftini* (Legaspi *et al.,* 1999; Reay-Jones *et al.,* 2005) and Eldana saccharina . Previous studies have revealed that the mean percent of yield reduction was 14.4%, up to 27.6%, sugar yield loss percent reached 0.7% on average, up as high as 0.8% due to the sugarcane borers (44).Thus it can be seen that occurrence of pests in combination specially are a tremendous source of loss and damage to sugarcane crop, such as in Yunnan recently, the loss of cane and sugar yield caused by *T. schistaceana* and *C. sacchariphagus* notably increased, and the main sugarcane cultivars were severely damaged by *T. schistaceana and C. sacchariphagus*. The damage from diverse pests such as, White *fly Neomaskellia bergii,Cane beetle Dermolepida albohirtum, Patchy sac spider Clubiona drassoddes* ,White grub *Holotrichia serrata* ,Seven spotted ladybird *Coccinella septempunctata,* Sugarcane beetle *Eutheola rugiceps , Convergent ladybeetle Heppodamia convergens,*Yellow top borer *Chilo infuscatellus,* Dark brown dragon fly *Epiaeschna hero(fabricus),*Green lacewing *Chrysopidea* ,Spotted stalk borer *Chilo partellus,* Differential grasshopper *Malanoplus differentialis/locust sp,* Sugarcane thrips *Fulmekiola serrata* ,Female sugarcane solider fly *Inopus rubriceps,* Dog bug *Coreus mariganatus* , Dragonfly *Anisoptera libellulidae,*Stalk borer *Chilo auricilius* ,Brown grass hopper *Hieroglyphus banian* ,Crab spider *Thomisus onustus* ,Eldana borer *Eldana saccharina walker,* longed horned grasshopper *Tettigonidae,* Chinch bug *Bliss leucopterus,* Termite *Odontotermes obesus,Tricograma japonicum ,Apis dorsata (Hymenoptera:Apidae)* of sugarcane has become a major challenge that severely influence on high yield, stable yield and quality of sugarcane. Consequently, the chief task for cultivating quality, swelling profits, and safeguarding the maintainable and steady development of the Pakistan sugarcane industry will be the development of an effective control of pests during the entire growing period. Dead heart because of borers in the seedling stage is another source of main reduction of cane crop and yield**.** Other parameters that may impact sugarcane crop and yield is damaged stalk during middle and later growing stages due to pests along with destruction of internal tissues severely reduce the quality. The socioeconomic condition to a greater extent of the people improved in all age groups related with the cane crop. In the current study cane plant was susceptible to injury throughout the whole growing season. To control these pests a consistent effort should be fixed towards prevention and integrated control with an emphasis on both early warning and surveillance [45].

Table 2: Loss in sugarcane production due to pest incursions.

Name of pest	(%) Reduction in Cane Sugar	(%) Reduction in Sugar Recovery
Early shoot borer	22 to 33	2 .0 -3.0
Internode borer	34.88	1.7-3.07

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Top shoot borer	21-37	0.2-4.1
Stalk borer	33	1.7-3.07
Root borer	35	0.1-0.8
Scale insect	32.6	0.3-2.90
Black bug	86	16-20
Pyrilla	35	0.1-2.8
White Fly	31.6	1.0-1.5
White grub	80	1.4-1.8
Whiter grub	100	5.0-6.0

Source: Sugarcane Pests and Their Management, J Srikanth, KP Salin, R Jayanti, Sugarcane Breeding Institute (ICAR) Coimbatore.

Conclusion

It's concluded that crucial measures, adopting such practices as, light trapping and biological control to reduce the pest source is required to minimize the impact on crop along with application of 3.6% Bisultap GR and relevant chemicals in the seedling phase, the middle and later growing stage should be assumed and considered as a vital part of pest management (Figure 3). The main purpose of the research was to collect the pertinent role in the field of pests in sugarcane pests and their impact on crop. Therefore, paper is very valuable for farmers and research students to get detail about relevant topic.

a) White fly *Neomaskellia bergii*

b) Patchy sac spider *Clubiona drassoddes*

c) White grub *Holotrichia serrata*

d) Seven spotted ladybird *Coccinella septempunctata*

e) Sugarcane beetles *Eutheola rugiceps*

f) Convergent ladybeetle *Heppodamia convergens*

g) Yellow top borer *Chilo infuscatellus*

h) Dark brown dragon fly *Epiaeschna hero*(fabricus)

i) Green lacewing *Chrysopidea*

j) Spotted stalk borer *Chilo partellus*

k) Differential grasshopper *Malanoplus differentialis/locust sp*

l) Sugarcane thrips *Fulmekiola serrata*

m) Female sugarcane solider fly *Inopus rubriceps*

n) Dog bug *Coreus mariganatus*

o) Dragonfly *Anisoptera libellulidae*

p) Stalk borer *Chilo auricilius*

q) Earwing *Forticula aurcularia*

r) Brown grass hopper *Hieroglyphus banian*

s) Crab spider *Thomisus onustus*

t) Eldana borer *Eldana saccharina walker*

u) Tettigoniidae nymph

v) Chinch *bug Blissus leucopterus*

w) Termite *odontotermes obesus*

x) Tricograma japonicum

y) Honey bee *Apis dorsata.*

Magnification= (100X).

Data Availability

The data not used to support the findings of this study are not included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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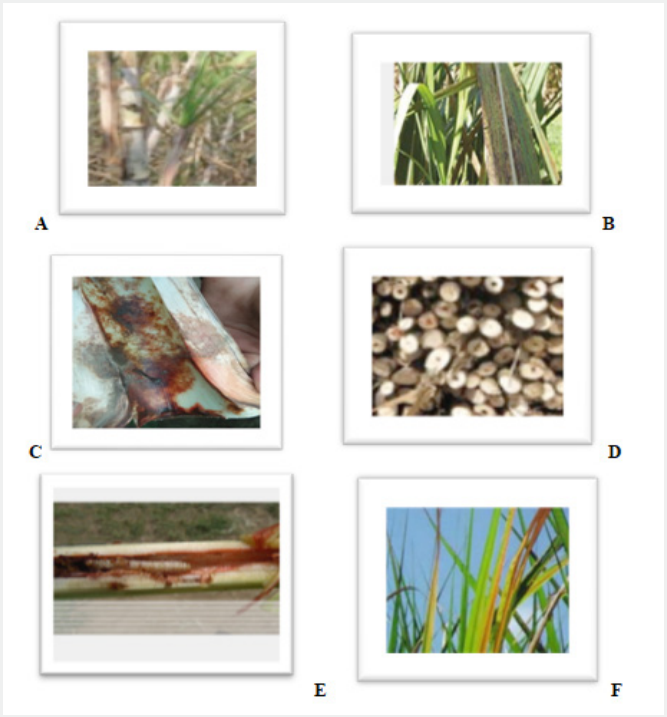

Figure 3: Sugarcane crop variety HSF 234 damage affecting plant leaves and stalk at district Rahim Yar Khan Tehsil Khan Pur in Relation to pests infestation of sugarcane crop (A-F).

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