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STATUS OF BIOLOGICAL CONTROL IN PAKISTAN

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ABSTRACT

Biological control is not a new phenomenon in human history. It is the control of pests through living organisms. It is less destructive to the environment. It is self-perpetuating and comparatively less expensive. It needs much more expansion in Pakistan. The experience of biological control started for me in 1963 when I was a student. Afterward I explored this work in various institutions of the country where I had a chance to work. I started establishing biological control laboratories especially for mass rearing of *Trichogramma.* Important basic and applied work has been accomplished. Moreover, the work on biological control undertaken has been compiled and published.

1. INTRODUCTION

Insects using plants as their food have existed since the birth of this universe. With the development of agriculture this association attained economic significance. The human settlements started to tackle this problem as per demand. Presently everything is materially evaluated so this sector has got the highest priority due to food demand. Within known history of agriculture, insects are killed by various means to reduce the food loss. The most common tool is chemical control. The extensive and intensive use of chemical control caused many problems. This was also realized in Pakistan, therefore lesser use of pesticide was recommended (Irshad, 1978). When this issue came in to limelight some other control strategies were tried. There is a balance of population of living organisms. In this concept balance of insect populations within ecosystem was also present. In this scenario the population of each species was balanced. This phenomenon was understood by many professionals dealing with the issue. This was utilized for the benefit of humans. So biological control protocol emerged.

Biological control is a component of an integrated pest management strategy. It is called the reduction of pest populations by natural enemies. Biological control is the use of living organisms to suppress pest populations, making them less damaging than they would otherwise be. In the field, natural enemies of insects play an important role in limiting the densities of potential pests. Natural enemies include predators, parasitoids and pathogens. This is environmentally friendly because it only affects the target pests. It is a self-sustaining process and therefore cost effective.

Introducing a new species to an environment runs the risk of disrupting the natural food chain. It is a slow process. It takes a lot of time and patience for the biological agents to work, whereas other methods like pesticides provide immediate results. If you are looking to completely wipe out a pest, biological control is not the right choice. While it is cheap in the long run, the process of actually setting up a biological control system is a costly endeavor. A lot of planning and money goes into developing a successful system.

Work on biological control has been undertaken in Pakistan since emergence of the country. However, the Commonwealth Institute of Biological Control was established in 1957 in Rawalpindi. Its sole responsibility was biological control. It was an international institution. Since its establishment a lot of work has been conducted, mostly on foreign funded projects. Work on biological control in Pakistan has been documented (Irshad & Haq, 2010; Haq & Irshad, 2011). Concept and importance of biological control work for Pakistan has also been discussed by (Irshad, 1968; 1987). There are various biocontrol agents. Role, food habits and speciation of coccinellid has been dealt by Irshad, (2001) and Rafi et al., (2005). Similarly, syrphid contribution in biological control of Pakistan has been made known by Irshad, (2014). In addition, the importance of identification of

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natural enemies has been evaluated by Irshad et al., (2006).

The world of biological control has expanded and commercialized. Not only local natural enemies have been utilized for the benefit of humanity but advanced countries have imported these from other areas and got maximum benefits. From Pakistan many biotic agents have been exported and these benefits have been documented by Irshad, (2015).

2. MATERIALS AND METHODS

Practical biological control is not an old phenomenon. However, it existed as natural control since earliest human settlements. However, its first emergence emerged when I was a student in 1961-1963. From then, I had interaction with this subject since my earliest scientific career. I was in touch with biological control work and with biological control scientists in the world and also with world literature. I had been working with well-known biological control scientists of Pakistan like Drs. M. A. Ghani and A. I. Mohyuddin. I was in touch with the authorities of the time like Dr. F. J. Simmonds, B. R. Bartlett & D. J. Greathead. During this time, I collected a lot of information and literature. Since 2003, I started compiling biological control work about Pakistan. I was the earliest scientist to be working on insect pest management since its birth. I attended the first FAO sponsored IPM conference on cotton in 1975 in Karachi. This helped me in increasing my knowledge about biological control in Pakistan. This also enabled me in writing this paper. Help also came through my practical experience of biological control work.

3. RESULTS AND DISCUSSION

My exposure to Biological Control Work as Student.

During my MSc. (1961-1963) my professor was Dr. M. A. H. Qadri who was FRS and got a PhD under the supervision of Dr. A. D. Imms, the renowned entomologist in the world. Dr. Qadri was working on a project which dealt with natural enemies of cotton insect pests. I witnessed this work and became in contact with biological control phenomena as a student. This was my first exposure to bio control work. He used to say that forest ecology is best suited for this work.

Pakistan Council of Scientific and Industrial Research, Karachi.

When I started practical research work, I was exposed to this sector of entomology immediately. I started research on the feeding habits of predatory coccinellid beetles. The prey included mites and aphids. This was a simple lab. work but was quite interesting (Anwarullah et al., 1966). I was so over helmed that I started writing a review paper on this subject. I completed this paper and published as Biological Control of Pests and its Scope in Pakistan (Irshad, 1968).

Commonwealth Institute of Biological Control, Rawalpindi.

As per my future professional destiny I got the chance to serve CIBC, the mother organization of present CABI Bioscience. This institution used to work on biological control of insects, mites and weeds all over the world. Thus, I was exposed to the world of biocontrol. Here our work included both applied and basic. Our basic work at that time was severely criticized by both administrators and applied plant protectionists. They considered it to be a waste of time and money. This proved to be wrong by the time as the present integrated approach mainly relies on this basic knowledge. Biological control requires basic information like biology, ecology, taxonomy, behavior and feeding habits of both pests and biotic agents.

Here I started work on pentatomids of graminae. No doubt it was basic work but we were able to explore local biocontrol agents attacking these insects. Among these egg parasitoids were of significance (Cheema et al., 1973). I also conducted a few experiments with NPV and DD 136 nematode to control some insect pests but could not get satisfactory results. These are microbial insecticides.

My next assignment was natural enemies of house flies. It was a short assignment. In this project we explored parasitoids and predators of flies that breed in dung and vegetable refuse. Some of the work was of significance for the USA.

Afterwards I started work on natural enemies of grasshoppers. This was significant study for me. An important finding of this work was making known of egg parasitoids of grasshoppers. These recorded species mostly belonged to the genus *Scelio*. These species were new to science.

Even some of the recorded species belonged to new genera (Irshad 1977; Irshad et al., 1977ab; 1978). At that time no taxonomist was available in the world who worked on this group. Nobody has worked on this group extensively in Pakistan. Up till now only two references can be found on this topic for Pakistan. We in 1973 tried to describe these species but failed as we were occupied in other biological control work. These biotic agents can be used in the control of locusts and grasshoppers. These can easily be mass reared and released in the field. I have also compiled the list of *Scelio spp.* of the world and this list can be used for applied biological control work anywhere in the world (Siddique et al., 1986). *Scelio* spp. can be easily mass reared and economically used to control rice grasshoppers and locusts. Another small study included nematodes as parasites of grasshoppers (Irshad, 1977a).This information was important in the sense that it was a new organism for Pakistan. Another point of this study was recording of adult and nymphal parasitoids of these insect pests (Irshad et al., 1985).

Next I started work on lepidopterous insect pests of crucifers. This was an interesting assignment. Here we not only recorded the biotic fauna of these insect pests but did some augmentation and redistribution work. The most significant work was on *Cotesia plutellae* Kurd. which is an excellent biotic agent of *Plutella xylostella* Linnaeus and used in many countries of the world (Mushtaque et al., 1993, 1995).

The juniper is an important forest tree of Baluchistan. Many juniper trees have died. One of the reasons considered was to be a parasitic weed feeding on this forest tree. I studied natural enemies of this parasitic weed, *Arceuthobium oxycedri* M. Bieb. of juniper tree. It did not provide any significant clue for biological control of this weed. However, we were able to collect some basic information which when required can be used to tackle this weed and also some other weeds in forests (Baloch et al., 1985; Arif et al., 1986).

Pakistan Agricultural Research Council, Islamabad.

I shifted to work on a project Pest Management Project under Pakistan Agricultural Research Council, Islamabad. This project dealt with insects, pathogens, nematodes and weeds associated with cotton, paddy, sugarcane and maize crops. I started work on sugarcane pests in 1975 and this work included biological control. This study provided some interesting facts around 1977. It was previously reported that *Epicrania melanoleuca* Fletcher, the ectoparasitoid of *Pyrilla* was not present in KPK so a few hundred *E. melanoleuca* were redistributed from Faisalabad to Peshawar and Mardan by CIBC in 1974. Its distribution was not monitored until we found it in millions and occurred through KPK extending from Peshawar to Swat, Haripur and Abbottabad. Not only its occurrence was well distributed, but it had significant impact on the control of *Pyrilla*. It also revealed that this parasitoid was more abundant in unsprayed areas than sprayed, especially aerially sprayed. At that time this area was subject to extensive and intensive aerial spraying. It is well known that natural enemies, especially parasitoids, are more susceptible and vulnerable to pesticides than pests. Some professional entomologists consider the use of pesticides a cause of outbreaks of pests. So a campaign was started to reduce and stop aerial spraying so as not to destroy the environment. This was a successful event and aerial spraying was stopped not only in this area but also paved the way for whole of Pakistan. Other work on biological control of sugarcane is by Irshad and Rahtullah, (1982); Irshad & Siddique, (1982).

Along with this in Mandi Bahauddin sugar mills established a *Trichogramma* lab. by then CIBC, but this could not sustain the test and soon stopped working but this paved the way for future establishing such labs. Technical knowledge was not available at that time and also chemical control had full grip on pest control.

Dr. E. King, USDA visited us around 1976. At that time, I was rearing *Cotesia flavipes* (Cameron) for sugarcane borers. During discussion he remarked that will you be able to mass rear this parasitoid for releases. I had no reply. Then he said that he has a well sophisticated lab. in the USA for this purpose. He has four groups of technicians each headed by an entomologist. One was responsible for rearing of host eggs, second for rearing of parasitoid, other for releases of trichocards and final one to evaluate the release results. This proves that we were not well equipped at that time for biological control work in Pakistan.

Around 1976 we helped Cotton Research Institute Multan in establishing biological control lab. but could not uphold the task.

In the year 1983, I presented a paper on sugarcane insects in Convention of Pakistan Society of Sugar Technologists. This paper won the best paper prize. Consequently, the delegates were much impressed (Mohyuddin et al., 1982). One of the sugar mills of Sind offered funds to CIBC to start work on biological control of sugarcane insects. This proved to be the first step in starting the first commercialized laboratory in the private

sector with the collaboration of scientists of the time. This venture proved to be such a tremendous success that multiple such laboratories started establishing in Sind and Punjab. I and Dr A. I. Moyuddin extensively advocated this issue in various meetings. This attracted the administrators and donor organizations. So, this sector started getting financial and administrative support. This approach extended to other crops. Meanwhile in the world, pest control people also realized this. Thus, support started coming also to Pakistan and international donors became aware of this. Along with this certain NGOs also started participating in this activity and hence more labs. started coming up. Many NGOs started building biological control labs. But an NGO, Eco Conservation Initiative did a lot of work with my collaboration. This NGO established many labs. in sugar mills of Punjab and started commercialized production of some biotic agents. The most serious obstacle in the biological control of sugarcane insect pests is mass rearing of the most important agent, *E. melanoleuca*. It has not been reared in mass neither in the lab. nor in the control field in Pakistan. Elsewhere there is no success in this also.

Pakistan Agricultural Research Council established its own *Trichogramma* lab. at Multan at Cotton Research Institute around 1998. This started releasing *Trichogramma* in cotton belt of Multan. This lab. was later shifted to NARC Islamabad. We got assignments from different sugar mills of Punjab to help them in biological control of sugarcane insect pests specially borers and *Pyrilla*. As we had nucleus lab. at NARC, we started its enhancement. Subsequently an advanced lab. started coming up in Islamabad. We also established such labs. in various sugar mills of Punjab. These laboratories helped in controlling sugarcane insects through biotic agents. These labs. expanded their activities to breed and release other biotic agents like *Chrysopa*, Coccinellids and *Cotesia*. Most of the work was on augmentation and redistribution of biotic agents. This approach is now well spread in sugarcane crop in Pakistan.

Microbial control is a component of biological control. It manages insect populations through diseases caused by bacteria, viruses, nematodes and protozoa. It has attained great significance due to environmental hazards caused by extensive and intensive use of pesticides. This type of control has some significance in the light of Pakistan conditions (Irshad 1999; Irshad & Baloch, 1984). Testing of microbes has also been done in Pakistan (Irshad,1978a; Irshad et al., 1982; Irshad & Mohyuddin, 1988).

Mr. Pope, Pasteur Institute Paris, visited Pakistan around 1976. After having discussions with Prime Minister of Pakistan, he visited us for technical discussion. He was interested to help install a plant in Pakistan to manufacture a microbial pesticide. As a consequence, he provided us Bactospeine a microbial pesticide in bulk and we were supposed to have testing as per Pakistani law. However, this thing never materialized. So, we missed a chance for microbial pesticide mass production.

I was also exposed to biological control of fruit flies of fruits especially mango and guava. I participated in working in the lab. and field for *Aganapis* (*Trybliographa) daci* (Weld) and *Diachsmimorpha longicaudta* (Ashmead). It was quite interesting and adaptable study as now fruit fly is managed through this and traps. This is very difficult insect pest throughout the world and also in Pakistan. Pesticidal control had not so far been successful. The hazards of chemicals are quite well known for this. Biological control with integration with pheromone traps is widely practiced with some appreciable control.

Exposure in the Philippines.

In1979, I had a chance to work in big Cocoa plantation of Philippines to control cocoa pod borer, *Acrocercops cramerella* Snell. It was previously managed by pesticides extensive use. This did not provide control but destroyed the crop in whole of Philippines. Here we started managing the population of this pest through releases of local *Trichogramma* species. First of all, the local *Trichogramma* was identified and given the name as it was a new species. A very sophisticated laboratory was established employing a few entomologists and about a dozen technologists. The technicians were divided into groups. The first group was responsible for mass rearing of host *Corcyra cepholonica* (Staint), so this group was responsible for supplying necessary host eggs. The next group assignment was rearing of *Trichogramma*. They exposed the host eggs to the parasitoid adults for parasitization so as to get trichocards. These trichocards were distributed daily in the field as per requirement. The cocoa seeds obtained from biological treated blocks were sent separately to exporting country and fetched higher prices. This was a very successful venture and the company started making significant profits (Irshad et al., 1984).

Compilation work.

To put my practical experience of biological control, I undertook writing in different ways. I had a desire to compile work on biological control as a large portion was not published and not available to many scientists. I started to compile this work of Pakistan around 2000. It took 8 years to finish this job. Finally, a book was published in 2008 under Higher Education Commission Islamabad with 309 pages (Irshad, 2008). This is a textbook for higher education students of M.S and PhD biological control. It is significant in the sense that few textbooks by local authors are available in Pakistan. Very little effort has been made in this direction. Different chapters of this book include introduction, concept of biological control, parasitoids of Pakistan, predators of Pakistan, pathogens of Pakistan, biological control of weeds, practical application of biological control in Pakistan, rearing techniques of natural enemies, role of biological control in integrated pest management, future of biological control and appendices.

I also started compiling natural enemy fauna of Pakistan. It started in phases. First, I compiled a list of parasitoids, predators and pathogens in Pakistan in 2003 (Irshad, 2003). This was modified and reshaped in 2005 as insect pests of plants and their parasitoid, predators and pathogens in Pakistan (Irshad & Khan, 2005). This list was further enlarged and enhanced (Irshad & Stephens, 2013; Jilani & Irshad, 2008). In this final compilation of list of natural enemies, there are 753 species of parasitoids, 379 species of predators and 29 species of pathogens. Thus a total of 1161 species of natural enemies have so far been recorded. No doubt it is an appreciable number because so far work conducted on this subject is quite meagre. With some excessive and intensive work much more number will be made known. Experiences of Pakistan was also published (Haq & Irshad, 2011).

For using natural enemies in 2001, a booklet on establishment of *Trichogramma* mass rearing laboratories at Shah Taj Sugar mills was published (Irshad et al., 2001). Mass production of *Trichogramma*, a useful biotic agent, was also published (Haq & Irshad, 2009, 2009a).

These publications may look small contributions, but no parallel such compilations were available for Pakistan. These compilations were responsible for starting and expanding practical biological control work. Much more effort is needed in this regard, especially some important basic work.

4. CONCLUSION

Apart from above work other institutions have also undertaken basic and applied wok on biological control of different insects and weeds but still it is insufficient. The present work is mostly in projects undertaken under foreign funding on cotton, vegetables and fruits etc. There is lack of a national institution which should exclusive take the biological work. Thus it is undertaken in projects which stop when some assignments are finished. An attempt was made in 1977 to establish an exclusive national institution on biological control but this did not materialize. This is an important need of the country.

Present Integrated Pest Management has evolved from integrated control strategy. Prior to this, pest control was a mixture of various control measures. Of all these, chemical control was most dominant. The integrated control concept was integration of chemical and biocontrol measures so that environmental hazards can be minimized. Around the 1960s pesticides emerged to be major cause of environmental degradation. Information on chemicals was enormous at that time but knowledge on biological control was not enough in the world. So, studies on biological control got impetus. After a few years around the 1970s the idea of integrated pest management got into prominence. This involved all the control measures so as not to disturb micro and macro habitat/niche of this universe. Hence biological control studies have to be enhanced. It is claimed by some scientists that both biological control and IPM of a pest cannot be successfully done unless you have more than 200 well documented research papers on biology, ecology, food habits, distribution food chain etc. of the pest and natural enemy.

In the last 10-20 years practical biological control work has been undertaken which evolves mostly on non-active insects like mealy bugs, scale insects, whiteflies etc. It is mostly conservation and augmentation. Redistribution is mostly prominent of sugarcane *Pyrilla* by *Epicrania*. Importation is almost negligible.

Pesticide trade has a strong hold in plant protection activities therefore biological control has a great challenge in this sector. We were working with sugar mills in Punjab on sugarcane insects. During our visit we found that sugarcane insect pests have just started their activities on the crop. We asked not to have chemical control this time. We gathered population data of pests and their natural enemies.

After a month we again visited the area. The area was sprayed in spite of our advice of not spraying. When we monitored the pest population it was not different in the two ecologies of sprayed and unsprayed. Even the natural enemies were comparatively more abundant in the unsprayed fields. This shows the power of pesticide dealers.

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