Bruchid pest management in pulses

Introduction:

Pulses are the highly nutritious seeds, belong to the family Fabaceae (formerly named as Leguminosae), which usually covers all legumes grown for their dried seeds (COPR, 1981). This inhabit an indispensable position in human nutrition not only because of its rich source of high quality protein, but also for its dietary fiber, complex carbohydrates, resistant starch, complex of vitamins and minerals such as folate, potassium, selenium and zinc (pulses crops for health). Additionally, they are utilized as animal feed, firewood and also participate in a symbiotic relationship with a group of bacteria that restore soil fertility by oxidising atmospheric nitrogen, adding organic matter, enhancing phosphorus availability, and improving physical, chemical and biological properties of the soil (growth and production of pulses). The term pulse is derived from the Latin word “ Puls pultis” meaning thick slurry (application and opportunities), made by boiling dry seeds, which differs slightly from the legume, derived from the Latin word ‘’Legere,” which means to gather. According to Muhammad Asif et al., every pulse is a legume and the definition of legume is “ any dry fruit or pod” that contains seeds or dry grains that fix nitrogen into the soil (application and opportunities). Therefore, pulses include all the leguminous crops grown for their dried seeds except the crops used for oil extraction, such as Soyabean and groundnut.

Pulses are next to cereals as a source of food, especially in developing countries (application and opportunities). Pulses proteins are chiefly globulin and contain low concentrations of sulfur containing amino acids, viz. methionine and cystine, but a higher concentration of lysine than cereals

(growth and production of pulses). Likewise, pulses also contain more calcium and iron than cereals. Thus, pulses provide a perfect cocktail of essential amino acids with high biological value when supplemented with cereals. Therefore, pulses are considered as the primary protein source for vegetarians and are also called the poor man’s meat (Reddy, 2010). This is named so because most of the poorer sections of the population are not able to afford non-vegetarian items for their diet. In fact, pulses contribute a lot for them as they get vegetable proteins, along with minerals and vitamins in their diet, while investing less. The consumption of pulses is increasing globally in view of their high nutritional value, and also because they are low in calories and glycemic index (application and opportunities). Furthermore, pulses provide healthy proteins compared to other protein-rich sources like meat and meat products (Ready et al, 2013).

Despite of the above fact, the global production of pulses is not on par with consumption. In the last decade, starting from 2003 to 2012, average pulse production in the world is about 63937613. 687 million tonnes and Asia contributes about 45. 62% of that. US farmers harvest about 2. 6 million pounds of pulses every year. Out of these, 75% have been exported internationally because of its increased consumption in the developing countries (application and opportunity). Surprisingly, India is the largest producer, consumer and importer of pulses which contributes about 14749430 million tonnes in the last ten years (2003-2012) i. e. 23. 07% of the world’s production and 50. 57% of the production of Asian continent (FAOSTAT). Being the world’s largest pulse producer, in India, there is still a huge shortage of pulses and also, the prices are not affordable to a large

section of consumers. This is because the productivity of pulses is low. Still, India is not in the top five countries delivering highest yield (FAOSTAT, 2014). An immediate need is the detection of problems associated to the lesser yield, development and dissemination of low-cost technologies appropriate to the problems. So that pulses are affordable to the common man.

Even though global pulse production comparatively increased by 12. 11%, in this decade (2003-2012), during the last two decade (1993-2012), the cost of production and consequent prices are still too high for the average citizen. Various biotic and abiotic factors responsible for the yield loss are considered as the source of such price hike. Storage pests, especially, feeding on seeds have emerged as the most important biotic constraint, and cause considerable economic losses at the end of the harvest period and during storage. Among the 14 important insect pests of stored grains and pulses recognized, bruchids cause extensive damage during the post harvest storage (Sharma, 1984) and are found mostly in the tropics and sub-tropics. Since the discovery of the family Bruchidae, More than 1700 species under 62 genera are known worldwide (Romero and Johnson, 2004). About 20 of them are recognized as the important storage pests of pulses, especially, in developing countries (Southgate 1979; bioassays with bruchid beetle). The Indian diversity accounts for 108 species belonging to 11 genera which included in 3 subfamilies. Despite the major losses caused by Callosobruchus chinensis, C. maculatus, C. analis, Acanthoscelides obtectus and Bruchus incarnates, some of the other bruchid species such as B. rufimanus, B. dentipes, B. quinqueguttatus, B. emarginatus, B. ervi, B. lentis and B.

pisorum may also cause considerable losses in a number of legumes (Breeding Food Legumes for Resistance to Storage Insect Pests)[4, 6]. In addition, Bruchus pisorum, B. Rufimanus and Bruchidius atrolineatus are the primary pest in the field and during the early period of storage. India produces around 12. 65 million tonnes of pulses per year and nearly 8. 5% of this is lost during post harvest handling and storage (Agarwal eta., 1988). Since a decade ago, world-wide research work on bruchid control is in progress and many reports are also available from different countries, but not much information is available on the extent of damage and on yield losses because of bruchid infestation. It is reported that world-wide a minimum of 10% of cereals and legumes are lost after harvest (Boxall et al., 2002). Similarly, in Ethiopia the losses have been reported to reach up to 20-30% (Abraham, 1996). According to Ali et al. (1994) and Damte et al. (2006), it is predicted that, around 50% of product loss may cause in some of the important legumes such as faba bean, field pea, chickpea and lentil due to some potent storage insect pests like C. chinensis. Another two group of researcher estimated that it may exceeds 40% (Caswell 1981; Cardona & Karel 1990 [bioassay with bruchid beetle). However, it is widely accepted that food losses after harvest can be significant and are important in terms of quantity, quality, nutritional and economic value (Golob et al., 2002).

With the passage of time, crop loss assessment is viewed as a prerequisite for pest management. Innumerable efforts have been made in this context to develop suitable techniques for the recovery of pulses from bruchid invasion. In general, cultural, biological, chemical and botanical methods are considered as crucial for successful control of the most dominant stored

product pests (Gwinner et al., 1990). More or less all these methods have proved worthy in controlling storage insect pests. Subsequently, it was seen that none of the above methods proved effecient for improving the productivity and complete eradication of the storage pest due to several reasons. Mainly, these methods are slow and consume much time. Further, traditional method (e. g. cultural) exhibits certain biological limitations and requires much attention throughout the farming period, biological method needs the utilization of certain pathogens, botanical method requires high costs and chemical method associated with some drawbacks including high costs, environmental pollution and concern about food safety.

Recently, Biotechnology and molecular plant breeding has came forward as a promising technology towards a permanent solution to the said problem. This tool assured to boost the productivity in terms of better quality and quantity, being associated with traditional breeding techniques. Molecular marker technology, as a tool of Biotechnology, has revolutionized the entire breeding program by facilitating the marker assisted selection of desired genotype (DNA fingerprinting of major pulse crops of India). This ensured the incorporation of bruchid resistance trait from wild relatives to the cultivated accessions either though trans-genesis or MAB. As a consequence of which an environment friendly and sustainable management of these insect-pests would be possible. In this paper, we have attempted to make a clear vision about the adverse effect of bruchid pest in pulses, tools implemented for their management and discussed some possible ways for their eradication. The paper analyzes the global production, consumption, yield and nutritional value of pulses and strongly argued that an improved package of practices,

including biotechnological interventions, is essential to improve the productivity and yield stability in pulses

Nutritional value of pulses in comparison to cereals, meat and milk:

The nutritional value of pulses is of great importance. The energy required for all the metabolic processes is in pulses, which come from the nutrient supply of protein, carbohydrate and fat (the role of pulses in human nutrition). The energy content of most of the pulses have been found to be between 329 and 364 Kcal/ 100 gram, which is nearly equal to the widely consumed cereals. Proteins are the essential component of diet performing diverse role in human body (Nutritional and Functional Properties of Some Promising Legumes Protein Isolates), including the synthesis of different hormones and enzymes required in metabolism, tissue repair and energy supply. The pulses are rich in high quality proteins, which are about twice in cereal grains and several times that in root tuber (FAO 1968). 100 gram of pulses contributes about 19. 30 to 25. 80 gram of protein while in cereals its value ranges from 6. 5 to 11. 5 gram. Among the essential food, Meat and meat products contains limited amount carbohydrates, with a massive amount of proteins and fats a too. (USDA National Nutrient Database for Standard Reference Release 26). However, due to high fat content, it has a negative impact on human health including the risk of cancer, obesity and metabolic syndrome (Meat as a component of a healthy diet – are there any risks or benefits if meat is avoided in the diet?). Despite the stated fact, meat is an important source of some essential micronutrients such as iron selenium, vitamin-A, B-12, and folic acid (Meat as a component of a healthy diet – are there any risks or benefits if meat is avoided in the diet?).

However, it is found that most of the pulses also contains significant amount of various vitamins and minerals except vitamin-A and folic acid. Similarly, more utilized milk fluids such as Buffalo milk, Goat milk, sheep milk and human milk contains smaller quantity of proteins and Carbohydrates compared to most of the pulses. In addition, milk fat contains a high fraction of saturated fatty acids which is expected to cause heart diseases, weight gain and obesity (Insel P, Turner RE, Ross D: *Nutrition* Second edition. American dietetic association, Jones and Bartlett, USA; 2004).

So, from the nutritional side, pulses contain a requisite quantity of proteins, carbohydrates, essential minerals and vitamins with a limited percentage of fat (USDA National Nutrient Database for Standard Reference Release 26). All these things taken together, pulses constitute a dominant portion of the balanced diet, and provide a large fraction of the energy rich materials with other vitamins and minerals and hence, are the staple food.

Adverse effect of bruchid pest infestation in pulses:

Likewise field pests and diseases, Pulses seeds are severely damaged by bruchids in storage condition and to some extent in the field. Species of this pest such as, *C. maculates (* Fabricius *), C. chinensis (Linnaeus), C. analis (Fabricius), and C. phaseoli (Gyllenhal) are mostly found* in *the sub trophical region. However, C. rhodesianus and C. sunnotatus are present in tropical region.* C. theobromae (Linnaeus) is also found in pods of pigeon pea in India. Acnthoscelides obtectus is the serious pest in rajmash (Post harvest management in pulses). The damage, caused by these pests, in storage is of multiple natures. It includes reduction in economic importance, nutritional

value, seed germination quality, seedling establishment, planting value of the crop, physical loss and contamination of product with uric acid, fragments and faecal matter (a study of bruchid resistance an its inheritance ……., effect of bruchid beetle infestatation on the germination of seeds, effect of fire, bruchid beetle…… in seedling establishment of pulses, effect of insect infestation and storage on the nutritional quality of pigeonpea, Post harvest management in pulses). It is previously reported that, grains which contains above 10 insects and 10 mg of uric acid per 100 g are non-hygienic and unfit for human consumption (Venkat Rao et al, 1960; Prevention of food adulteration act of 1967). Hence, a large quantity of pulse products are destroyed or contaminated every year. This disseminates food shortage and reduces the earnings of farmers. Since, grain legumes alone contributes 33% of the dietary protein nitrogen (N) (Vance et al., 2000) and other essential vitamin and minerals required for human beings, the loss during storage is considerable significance when viewed in the context of the acute shortage of protein and protein malnutrition, particularly among people living in the rural areas. It is found that, above 70% of grains harvested in Africa are stored for human consumption or for marketing (Mallamaire, 1965; Talabi, 1989). Similarly, In the Sudan and Guinea Savanna of Nigeria 40-85% of grains harvested are stored (Ivbijaro, 1989). Out of total pulse production in India, about 8. 5% is lost during post harvest handling and storage. Thus, if bruchid pest infestation is taken into consideration, a comprehensive relationship will be established between the commodities stored, their relative production and product loss during storage i. e. the quantity of pulses produced is directly proportional to the product to be stored and losses during storage. Therefore, Securing the

harvest against storage pests is necessary because production of most food crops is done only once in a season under a rain-fed system. This one major harvest in the year has to provide for the needs of both the urban and rural areas throughout the year.