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Conservation Agriculture: An Option to Enhance Pollinators and Sustainability

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Abstract: Pollinators provide an essential ecosystem service that contributes to the maintenance of biodiversity and ensures the survival of pt species including crop pts. Furthermore, the reproductive success in pts is often pollinator limited. Most of the vegetable crops are cross-pollinated i.e. the flowers of these crops need conspecific foreign pollen for pollination and seed set. Insect pollinators set a greater proportion of early flowers of the crop and increase quality and quantity of the seed yield. Heat, soil moisture/ water availability to the pts during drought periods are some major factors that decide the number of pollinators in the crop. Conservation agriculture is a technology for maintaining soil quality, retaining soil moisture for longer period, reduces irrigation need of the fields optimises pesticide & fertilizer use and moreover helps in creating the natural habitats for the pollinators and natural enemies." Conservation technologies collectively helps in reducing the use of pesticides and fertilisers, better crop growth and most important good population of pollinators and natural enemies in the fields.

Key words: Pollination · Biodiversity · Conservation agriculture · Climate change · IPM

INTRODUCTION

Global food supply has kept pace with demand in the past four decades due to impressive economic growth and linking global markets. There has been a tremendous shift in the production variables of modern farming over traditional farming with main shift in agriculture from 'traditional animal based subsistence' to 'intensive chemical and tractor based' agriculture. But efforts to produce ever-more amount of food due to burgeoning population leaves its adverse effect on the environment, its habitats and problems associated with sustainability of natural resources. To compound the challenges further, global climate change is likely to impact agriculture through high incidence of biotic and abiotic factors and other components of agricultural systems, making production much more variable than at present [1]. Intensification of drought, floods, cyclones and rise in temperature and changes in growing periods of crops is one of the predictable impacts of climate change and climate instability. It dramatically alters the ecological communities and disrupts the timing of pollination with serious negative impacts on both pts and pollinators. Pollination is the process by which pollen is transferred in the reproduction of pts, thereby enabling fertilization and sexual reproduction. There are two types of pollination i.e. biotic and biotic pollination in crops. The biotic pollination requires pollinators. Around three-quarters of all food crops globally, primarily vitamin-rich crops, like fruits and vegetables, depend on insect pollinators. The vast majority of these pollinators are insects, such as bees, moths, flies, wasps and beetles [2]. It has been reported that near forests native pollinators improve agricultural crops yield by 20%. Insects indirectly benefiting humans include all insect herbivores, prey, predators and detritivores because they are an integral part of the biotic community of ecosystems [3]. The American Institute of Biological Sciences has reported that native insect pollination saves the United States agricultural economy nearly an estimated $3.1 billion annually through natural crop production [4], pollination produces some $40 billion worth of products annually in the United States alone (North America Pollinators Protection Campaign [5]). Pollination of food crops has become an environmental issue, due to two trends. The trend to monoculture cropping systems means that

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greater concentrations of pollinators are needed at bloom time. The other trend is the decline of pollinator populations, due to "chemical intensive agriculture" i.e. higher biocide use, changing climatic conditions leading to changing habitats for the pollinators, increasing urban sector and declining natural resources. Climate also plays a major role in determining the survival of the pollinators. Heat, soil moisture/ water availability to the pts during drought periods are some major factors that decide the number of pollinators in the crop. This overall is leading to a loss of pollinators/pollinators decline due to habitat destruction, pesticide, parasitism/diseases and others climatic and d management factors [6]. Consequently, challenges of the agricultural sustainability has become more intense in recent years with the sharp rise in chemical uses, increasing cost of food and energy, climate change, degraded natural resources and soil health coupled with financial crisis. Therefore, business-as-usual with regards to agricultural development is increasingly considered inadequate to deliver sustainable production intensification to meet future needs. A well-functioning ecosystem offers good ecological environment to the pollinators such as soil fertility, clean air and clean water. In the manuscript we will try to summarize the potential benefits of Conservation agriculture systems on pollinators and enhancing natural resources and their efficiency.

Pollinators and Agriculture: Three quarters of the world's crops and over 80 percent of all flowering pts depend on animal pollinators, especially bees. Globally the annual contribution of pollinators to the agricultural crops has been estimated at about US$ 54 billion. Pollinators participate in sexual reproduction of many pts, by ensuring cross-pollination, essential for some species, or a major factor in ensuring genetic diversity. Pollinators provide an essential ecosystem service that contributes to the maintenance of biodiversity and ensures the survival of pt species including crop pts. The angiosperms are the most beautiful gift of nature; these bear flowers. The variant coloured entities attract a wide variety of visitors; the ultimate attraction is the floral reward constituted by nectar and pollen [7]. Cross-pollination of flowers of entomophilous crops has a great influence on the quality of seed production [8]. It was investigated that seed set by honeybee pollinated onion increases by 2.7 percent [9]. Cane and Schiffhauser [10] observed six fold differences in mean pollen deposition translated into 15-20 fold differences in Cranberry fruit set and size. In onion, by keeping bee colonies in field, seed yield can be increased [11]. Most of the vegetable crops are cross-pollinated i.e. the flowers of these crops need conspecific foreign pollen for pollination and seed set. This is because of the certain reproductive barriers in these crops which make self-pollination ineffective [12]. Most varieties of Australian groves improve their fruit set with the presence of pollinators [13].

Like many other inputs in agriculture (e. g. fertilizers, pesticides and irrigation), managed pollination is also required as one of these essential inputs. In recent years, there has been an increase in the accumulation of data to indicate that seed yields of insect-pollinated crops may often be lower than the expected, not because of adverse climatic, edaphic or cultural factors, but simply because the number of certain pollinators is inadequate [8]. In many entomophilous crops, all the cultural practices would prove useless to affect fruit or seed set if its pollination is neglected. Insect pollinators set a greater proportion of early flowers of the crop and increase quality and quantity of the seed yield.

However, there are evidences of decline in their population and now it is urgent need to look to conserve the pollinators. Pollinator decline has not been limited to honey bees [14]. Declines have been observed in bumble bee species, including a 96% decline in four North American species linked to *Nosema bombi*, a microsporidian [15]. Our knowledge of most native bumble bee and solitary bees is so limited that it is difficult to say conclusively if the suspected declines in populations or loss of species is occurring only at the regional level or if the declines are global [14]. There are several factors contributing to the decrease in pollination. The factors causing this decline could be the decline in the habitat, with the accompanying decrease in their food (nectar and pollen), d use changes, increase in monoculture-dominated agriculture and negative impacts of modern agricultural interventions, e.g. use of chemical fertilizers and pesticides. Most pollinator species rely on a steady nectar source and pollen source throughout the growing season to build up their numbers. Farmers are practicing monoculture dominated agriculture which results in unavailability of food and habitat to the pollinators during unfavourable periods. Monoculture causes a brief period when pollinators have more food resources than they can use, while other periods of the year can bring starvation or pesticide contamination of food sources. A major determinant of Monarch butterfly population size is the availability of its host and nectar pt, milkweed, *Asclepias syriaca* [16]. Use of pesticides is the major reason for declining pollinators' population. Many insecticides are more effective at killing beneficial insects than pests, a growing number of people spray pesticides on their lawns and gardens. Even at low levels, pesticides affect longevity, memory, navigation and foraging abilities of the honeybees. The use of herbicides eliminates the natural forage that wild pollinators need before and after crops are in bloom. So selection of appropriate pesticide is vital [17].

Conservation agriculture (CA) is not 'business as usual', based on maximizing yields while exploiting the soil and agro-ecosystem resources. Rather, CA is based on optimizing yields and profits, to achieve a bace of agricultural, economic and environmental benefits. It advocates that the combined social and economic benefits gained from combining production and protecting the environment, including reduced input and labor costs, are greater than those from production alone. In addition to this, CA also provides a habitat for the pollinators.

The Principles of Conservation Agriculture: The CA offers farmers an array of practices, but at its core are three interlinked principles that can be applied in a variety of combinations:

Dramatic Reduction in Tillage: Zero-till or controlled-till seeding systems for optimum proportion of respiration gases in the rooting zone, moderating organic matter oxidation, improve porosity of water movement as well as its retention and release and also to limit the re-exposure of weed seeds and their germination.

Retention of Adequate Levels of Crop Residues/Organic Matter on the Soil Surface: Retain sufficient residue on the soil surface to protect the soil from erosion, provide buffering against impact of high solar radiation and rainfall beating, enhance soil organism activity, smoothing weeds and to enhance long term sustainable production

Implication of Integrated Pest Management (IPM): Encompasses baced use of cultural, biological, mechanical as well as chemical methods for keeping the pest population below threshold level. It is essential in conserving non target organisms such as pollinators.

Use of Proper and Profitable Crop Rotations: Employ economically viable and diversified crop rotations to break insect-pest cycle, biological N fixation, intensification for improving profitability and sustainability.

Conservation Agriculture Addresses Development:

Agricultural Production: CA has tremendous potential for achieving sustainable yield increases by improving the growth conditions for crops and the efficiency of input as well as increasing the pollinators' population and their efficacy.

Climate Change: CA reduces crop vulnerability to extreme climatic events. In drought conditions, it reduces crop water requirements by maintaining soil: water bace and deeper rooting, whereas, in wet conditions facilitates rain water infiltration. Indirectly reduces the pt stresses and provide round the year pollination environment through diversified cropping systems and better pt growth.

Natural Resource Base: CA reverses soil degradation processes and builds up soil fertility by facilitating better infiltration of rainwater and enabling the recharge of groundwater which reduces erosion and leaching and, in turn, water pollution.

Biodiversity: CA conserves and enhances biodiversity in the field.

Labour Shortage: CA eliminates power-intensive soil tillage, thus reducing the drudgery and labour required for crop production and enhances farm mechanization.

Livelihoods: CA gives farm families opportunities to improve their livelihoods. Farmers who adopt CA no longer need to spend time tilling and can use that time in other ways, such as on-farm processing, which adds value to their production

Scope of Conservation Agriculture: Conservation Agriculture (CA) systems are being practiced on 106 million ha worldwide and in South Asia on 3-4 million ha. The three elements of CA in various combinations aim at establishing and sustaining healthy crop-soil systems that can offer the best crop and livestock productivities and environmental services within the prevailing ecological and socio-economic conditions while optimizing the use of agrochemicals with biological interventions. CA provides a conducive environment through enhanced root-moisture interaction in root cone for effective capture of pt nutrients and water. A good pt health is crucial to increase and sustain the pollination, pollinators population and overall on the agricultural productivity.

So far very less work has been done on conservation agriculture and it's impact on pollinators. Future research and development issues should be studied for pollinator population in CA systems for example: regular monitoring of pollinators in the field, promoting the use of bio-pesticides, bioagents, lures, botanicals, development of location or crop based packages to conserve pollinators, empowering the farmers through farmers participatory approach, trainings etc.

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