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Review paper

Impact of monocropping for crop pest management: Review

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The paper was objected to focus on different issues and revises the impact of monocropping for crop pest management. Monocropping is continuous cropping as the practice of cultivation of the same crop in the same land year after year. Monoculture have it is on advantage in terms of rehabilitating deforested watershed Sand degraded landscapes, ease of management and increasing efficiency. Currently, monocropping is become less practiced and people are diverting toward using multiple cropping due it is several negative social and environmental impacts. According to one study, crop disease was reduced for about 20–40% because of intercropping compared to monocropping. Similarly, in a sorghum-Desmodium intercropping research reported, 100% control of Striga was achieved. Additionally, according to the report of one maize study, early emerging weeds can generate potential grain yield losses up to 35%. Comparing with multiple cropping, monocropping enhances the massive use of herbicides favors' weed resistance and generates water pollution especially when paired with irrigation and high nitrogen (N) fertilization. Monocropping also increase the impact of insects on crop production, however, their impact is differ from insect to insect based on their feeding habit. Clearly, in many cases multivoltine polyphagous insect populations will decrease with increasing monoculture whereas monophagous insects might increase with increasing monoculture. Furthermore, as indicated on the report of the study, the incidence soil-borne pathogens take-all disease was reduced by maize alfalfa intercropping while monoculture fields require more chemicals to control pests. Overall, currently due to different factors like climate change, the increment of population and pests, people are become diverting their practices toward multiple cropping systems.

Keywords*:* Disease, Insect, Intercropping, Monocropping, Pest Management, Weed.

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INTRODUCTION

Monocropping is continuous cropping as the practice of cultivation of the same crop in the same soil year after year. It occurs both extensively in agriculture with field crops amenable to mechanization and intensively in horticulture with highly specialized food or amenity crop production (Shipton, 1997).

Monocultures have been dominated in practice and well documented in forest research, but in the face of increasing climate change and resource scarcity; there is a growing interest in mixed-species plantation systems (Bolte *et al*., 2004). Many studies have identified that, most of the world plantations are monocultures, consisting of a small number of common trees (Kelty, 2006; Piotto, 2008). The improvement of crop productivity is the common aim of farmers and agriculturists, for sustainable agriculture probably lies in increased output per unit area together with arable land expansion. However, the recent demographic pressure has forced agricultural planners and development agencies to assess the role of multiple cropping as a means to enhance agricultural production, since the extent of suitable agricultural land is static or diminishing (Midmore, 1993). In terms of cropping systems, the solutions may not only involve the mechanized rotational monocropping systems used in developed countries but, also the poly-culture cropping system traditionally used in developing countries (Tsubo *et al.,* 2003).

The U.S. Department of Agriculture has recognized many problems associated with the increasing extent of monoculture in United States of agriculture (USDA, 1973). These problems range from simplification within the crop habitat by single-variety cropping and the use of herbicides and insecticides, to simplification of the landscape by the growing average of monoculture and the destruction of non-crop habitats (Andow, 1983). Several agricultural practices has been reviewed under different aspects however, the extent monoculture on pest management was not as such reviewed. Therefore, this paper focuses and revises sets of issues: how monoculture affects pest populations, the negative and positive impacts of monoculture and the comparative advantages and disadvantages of monoculture with mixed agricultural practices.

Positive aspects of monocultures

Monocropping is used for treating waste water and improving water quality (Minhas *et al.,* 2015); rehabilitating deforested watershed Sand degraded landscapes (Parrotta, 1999). Many different timber and other forest products can be grown in this kind of large-scale plantation system as well. Monocultures for wood and fibre products are dominating in the tropics (Kanninen, 2010). According to Chaudhary *et al.* (2016), non-timber monoculture plantations, particularly in tropical regions, can supply palm oil, rubber, plantain or bamboo. Countries in South America, Asia and southern Africa are promoting monocultures of pine and eucalyptus for paper pulp supply. There is also a fast expansion of rubber and oil palm monocultures in South-East Asia to meet the increasing world demand. Tree species in monocultures are mostly even-aged and planted at a high density in accessible areas, which allow the plantations to have easy management and high resilience; thus, higher yields per hectare and more efficient harvest resulting in uniform products can be obtained (Baltodano, 2000; Kelty, 2006 *et al.*, Piotto, 2008).

Negative aspects of monocultures

Research by various authors have criticized single species monoculture plantations as supposedly having several negative social and environmental impacts in spite of the recognized economic benefits (Erskine *et al.,* 2006; Alem *et al.,* 2015). Regarding the social impacts, the introduction of large scale plantations often leads to the change in the ownership from local communities to large private companies, hence, resulting into a loss of traditional goods and cultures, customary rights, and livelihoods associated with forced resettlement and unequal distribution of resources (Baltodano, 2000). Moreover, effects on the environment include the loss of soil productivity and fertility, disruption of hydrological cycles, risks associated with plantation forestry practices (e.g., introduction of exotic species), risks of promoting pests ,diseases, higher risks of adverse effects of storms, fire and negative impacts on biodiversity (Baltodano, 2000; Evans, 2001; Bowyer, 2006).This means being uniform genetic composition and closeness of tree species in monocultures, can provide a huge food source and ideal habitat for insects and pathogens, which will consequently give rise to rapid colonization and spread of infection (Hartley, 2002; Bowyer, 2006; Brockerhoff *et al.,* 2013). Monoculture plantations may deplete soil, causing soil erosion and degradation (Baltodano, 2000; Bowyer, 2006). Single-species plantations are also not efficient in trapping nutrients, because fewer roots exist near the surface, which may further lead to significant loss of nutrients from the harvest sites.

Felton *et al.* (2010) reviewed negative ecological and environmental impacts of monoculture plantations of spruce and showed that these plantations have lower resistance to biotic and a biotic disturbances aggravated by changing climates. The soils in those plantations become more acidic and subsequently generate unfavorable outcomes for biodiversity and other land uses in the long term. However, potential risks can be minimized with proper planning and good management practices of monocultures (Bowyer, 2006; Kelty, 2006).

Comparative advantage and disadvantages of monocropping with mixed cropping

Intercropping improves crop resistance to pests while monoculture sensitive to a biotic and biotic factors. According to Khan *et al.* (2001) study showed that intercropping Desmodium species with sorghum and maize enhanced soil fertility and increased the effectiveness of applied N in suppressing parasites. Intercropping of forage legumes enhances the disease resistance of companion crops. A general disease reduction of 20–40% because of intercropping has been reported (Hauggard-Nielson *et al.*, 2001). Similarly, a review by Lithourgidis *et al.* (2011) showed that the incidence of soil-borne pathogens take-all disease was reduced by maize alfalfa intercropping. Monoculture fields require more chemicals to control weeds, pests and diseases compared with intercropping (Seran, T.H. and Brintha, I., 2010).

Intercropping is useful in reducing the risk of crop failure because of the predicted increases in diseases and pests incidence related to climate change (Jeranyama *et al*., 2000, Lithourgidis *et al.,* 2011). Other studies by Jeranyama *et al*., (2000) reported the suppression of weeds in a lablab-cereal intercropping. Similarly, in a sorghum-Desmodium intercropping, 100% control of Striga was achieved (Reinhardt and Tesfamicahel 2011). Ejeta (2007) reported consistent reduction in Striga infestation in maize-cowpea intercropping relative to continuously cropped sole maize. Because of physiological and morphological heterogeneity that characterize mixed communities, mechanization of some cropping operations, like pesticide and fertilizer application, and harvesting is difficult in intercropped systems ((H., 2015).

Intercropping can conserve soil water by providing shade, reducing wind speed and increasing infiltration with mulch layers and improved soil structure (Torquebiau *et al.,* 1996, Young, 1997). The location of the different root systems in an intercropping system affects water uptake and the ability of each crop to compete for water resources (Sillon *et al.,* 2000). Intercropping maize with cowpea has been reported to increase light interception in the intercrops, reduce water evaporation, and improve conservation of the soil moisture compared with maize alone (Ghanbari *et al.,* 2010).

Negative effects of intercropping have also been reported (Casper *et al*., 1997). For example, in a field trial conducted on maize (Zea mays)/wheat (Triticum aestivum) intercropping, maize growth decreased in rows adjacent to wheat and the root system of maize was restricted during the early stage when intercropped with wheat (Li *et al.,* 2001, 2006, Zhang *et al.,* 2003). This suggests that the beneficial effects of intercropping only occur between crop species with contrasting nutrient requirements e.g. cereal legume. If so, this may imply that the intercropping of crop species with equal nutrient utilization efficiencies (e.g. cereal and legume intercropping) may cause direct competition for nutrients and therefore produce negative effects on both P uptake and yield. (Li *et al.,*2006).Moreover using other management practices such as cover crops, crop rotations instead of monocropping, and eliminating fallow periods can lead to C sequestration in soil (Casper *et al .,* 1997) can returning land from agricultural use to native forest or grassland (Dhima *et al*., 2006, Egbe *et al.,* 2007).

Monocropping and weed management

Crop diversification provides more control opportunities and disrupts the life cycle of weeds and their reproductive potential. Annual and perennial forages, especially when grown in rotation with annual grain crops, can be an effective strategy to reduce weed populations. Systematically changing planting dates and crop species prevents any one weed species from developing into a major problem (Derksen *et al.,* 2002). On the other hand, crop rotation may be an effective practice for controlling serious weeds because it introduces conditions that affect weed growth and reproduction, which may greatly reduce weed density (Derksen *et al.,* 1993). Early emerging weeds can generate potential grain yield losses of up to 35% in maize (Zea mays L.) (Bosnic *et al.,* 1997). Hence, herbicides represent 78% of the total number of pesticide applications at the referenced dose in French conventional maize monoculture (Blackshaw *et al.,* 2001). The massive use of herbicides favors' weed resistance and generates water pollution especially when paired with irrigation and high nitrogen (N) fertilization (Stoate *et al*.,2001).

Monocropping and Insect management

One study conducted on insect population identified how diversity of insects was increased in various ways in different crops. Therefore, cotton increased region-wide monoculture increased pest populations in 13 cases and decreased them in two. However, after the withdrawal of the insecticide, major pest populations declined, reputedly from the re-establishment of natural enemies. Although this is undoubtedly important, a largely ignored factor is that diversification of the cropping system occurred simultaneously with the reduction of insecticide use and the collapse of the pest populations (Shipton 1977). Boza Barducci (1972) argues that the reduction of monoculture was an important factor leading to the decline of the pest populations. One continuous wheat monoculture study for 12 years in north Kazakhstan examined the population dynamics of several insect pests and five pests reached outbreak populations the next year.

Furthermore, Shipton (1977) shows evidence that, several soil-borne pathogens of wheat become less severe after several years of continuous monoculture, while some pathogens of cotton become more severe, also indicating that there are real differences between wheat and cotton. The difference in pest population changes in response to changing patterns of diversity between cotton and wheat may be due to one of at least three factors: intrinsic differences in the crops; intrinsic differences in the pest complexes; or differences in cultural technique (Andow, 1983).

Clearly, in many cases multivoltine polyphagous insect populations will decrease with increasing monoculture. Many of these insects must change hosts between generations because neither host is present in an edible form during both generations. So as increasing monoculture eliminates the alternate host, which harbors the 'vast reserves' of the pest population (Uvarov, 1967}, these populations are expected to decrease. Monophagous insects might increase with increasing monoculture for two reasons. First, as the non-host habitat is eliminated, immigration to host habitats may increase and emigration from them should decrease (Andow, 1983).

Monocropping and Disease management

Review by Lithourgidis *et al.* (2011) showed that, the incidence of pathogens of soil-borne take-all disease was reduced by maize alfalfa intercropping while monoculture fields require more chemicals to control weeds, pests and diseases compared with intercropping (Seran, T.H. and Brintha, I., 2010). Practical and theoretical considerations suggest the possibility of several further patterns of disease and pathogen behaviors associated with monocropping continued for several years, and are more likely to be detected with soil borne than foliar pathogens. Similarly, monocropping can promote diseases, higher risks of adverse effects of storms, fire, and negative impacts on biodiversity (Baltodano, 2000; Evans, 2001; Bowyer, 2006).This means being uniform genetic composition and closeness of tree species in monocultures, can provide a huge food source and ideal habitat for insects and pathogens, which will consequently give rise to rapid colonization and spread of infection (Hartley, 2002; Bowyer, 2006; Brockerhoff *et al.,* 201).

SUMMARY AND CONCLUSIONS

Monocropping is continuous cropping as the practice of cultivation of the same crop in the same soil year after year. Pest management is one the principle of agronomic practice which used to reduce the incidence of pest and increase crop productivity. Monocropping can increase the incidence of crop disease for about 20–40% compared with intercropping. Similarly, in a sorghum-Desmodium intercropping, 100% control of Striga was achieved and showed that monocropping can aggravate the incidence of Striga. According to this review paper, one maize study reported early emerging weeds can generate potential grain yield losses up to 35%. Monocropping also increase the impact of insects on crop production, however, their impact is differ from insect to insect based on their feeding habit. Clearly, in many cases multivoltine polyphagous insect populations will decrease with increasing monoculture whereas monophagous insects might increase with increasing monoculture. As indicated on the report of the study, the incidence of soil-borne pathogens take-all disease was reduced by maize alfalfa intercropping while monoculture fields require more chemicals to control pests. Overall, monocropping is one the old agronomic practices at global level and currently different factors like climate change, the increment of population and pests are the major problem in crop production. Therefore, diverting our crop production system toward multiple cropping systems to increase crop productivity and improve the climate resilient is relevant.

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