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Water Logging: A threat to Agriculture Industry of Punjab

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INTRODUCTION

What is Water Logging?

Water logging refers to a condition when water is present in excess amount than its optimum requirement. It creates an anaerobic situation in the rhizosphere due to which the plant experiences the stress (O_2 deficient stress).

One of the most important environmental phenomena, water logging seriously harms agricultural land, which has an impact on the economy not only in Punjab state but also globally. Literally, "water logging" implies being drowned in water. Practically, it refers to the condition of land where the ground water table is permanently or even briefly situated or close to the soil surface with the result that the yield of commonly grown crops is reduced well below the normal for the land, or if the land is not cultivated, the high sub soil water table prevents it from being put to its normal use. When the water table rises to a level where the soil pores in a crop's root zone become saturated, the national committee on agriculture (1946) defined a region as being waterlogged.

Punjab makes up 1.57 per cent of India's total land area and cultivates more than 83 per cent of the country's total arable land (Statistical Abstract of Punjab, 2013). The Sutlej, Beas, and Ravi are three permanent rivers, and the Ghaggar is a seasonal river that runs across Punjab's southwest. Through the Sirhind canal, Sirhind feeder, Eastern canal, Upper Bari Doab canal, Bhakra canal, and Bist Doab canal, water from the rivers is delivered to agricultural fields for irrigation.

Following 3 decades, cultivation land of Punjab has been increased by the passage of time. Mainly, wheat and rice are grown in this region which has important role in fulfilling food demand of the nation. However, increasing productivity of these crops impacted groundwater table which led to decrease in water level (Krishan et al., 2013b).

Moreover, water logging has also resulted due to man made interventions such constructing huge canals throughout Punjab for helping farmers in irrigation which also resulted in increase in water logging in certain surrounding regions of canal. Incorrect canal alignment, seepage flow canals and distributaries, drainage obstruction, brackish groundwater quality, the nature and properties of the soil, poor irrigation techniques, cultivation of water-intensive crops, etc. are additional factors that have contributed to the issue of water logging. Natural factors including the presence of a topographic depression, an impermeable layer close to the land's surface, the lack of natural drainage, and constant rain add to the difficulty.

Losses due to water logging

Nutrient deficiency is one of the major effects of waterlogging on plants, resulting in reduced photosynthesis and net carbon fixation ultimately leading to a reduction in growth and therefore yield (Bange et al., 2004). Effect Waterlogging reduces oxygen levels in the root zone and reduces plant growth. Waterlogging increases the reducing power of the soil, changes the chemical balance of many elements, which enter the soil-water solution in the form of ions. Depending on the soil type, this change in chemical balance can be accompanied by transient toxicity of some soil nutrients that are normally safe if the soil is freely draining. Examples of this are iron and manganese compounds that can be converted to free ions at high reduction potentials of waterlogging on plant growth. After waterlogged soil is drained, it may take several days or more for reducing power to return to normal levels. Regular rainfall can cause repeated cycles of flooding and drainage, and soils can have a high reducing capacity for long periods of time. Clay that has been repeatedly soaked in water for an extended period of time often appears bluish-grey and can have a wetland smell.

Source: Waterlogging damages cotton, paddy in Mansa; threat looms over wheat-sowing, Hindustan Times 2017

Waterlogging and nursery flooding affect germinating seeds and young seedlings more than mature plants. Plants that are sown early and are well established can withstand waterlogging better than those that emerge during waterlogging. If submerged, the root tip will die within a few days. The loss of root tips limits the uptake of nutrients (especially nitrogen) and water after impoundment. As a result, waterlogged plants mature faster and grains are often pinched.

Reduced nitrogen loss and uptake by plants

Nitrogen is lost from waterlogged soils through leaching and denitrification – the process by which nitrogen is converted to gaseous oxides of nitrogen. These losses, combined with a reduced ability of plants to absorb nutrients from moist soil, turn older leaves yellow. Waterlogging also directly

reduces nitrogen fixation by legume and willow tubers. Adding nitrogen soon after waterlogging subsides can reduce the effects of waterlogging by making more nitrogen available to plants when they need it. Timely application of nitrogen to waterlogged crops can significantly increase yields and reduce the cost of nitrogen fertilizers.

Nitrogen fertilizers can be added as granules or liquids

Liquid fertilizers can be applied at any time because they can supply nitrogen directly to the foliage and crop canopy to replace the nitrogen normally supplied by the soil. Granular fertilizers are most effective when applied immediately after flooding.

Waterlogging can lead to degradation of soil structure

Soaked soils tend to disintegrate rapidly from the dispersion of clay particles. This is especially true in soils high in sodium. Flooded, non-dispersible soils can also lose soil structure due to collapses under its own weight in the absence of additional forces generated by soil moisture wicking from unsaturated soils and interference from machinery or livestock when the surface is saturated.

Impact on Fruits and Vegetables

There is near about 287744 ha area under cultivation of vegetables and 93615 ha is under fruits in Punjab. (Department of Horticulture, Government of Punjab). Water logging effects both vegetable and fruit crops. In tomato (*Solanum lycopersicum*) fruit setting percentage is decreased, maturity is delayed, decrease in number of flowers and fruits per plant, decrease in length and breadth of fruit resulting in overall decrease in yield of plant. The roots suffocate, uptake of nutrients also gets adversely affected, because of lack of oxygen in soil. N, B, Mg, and K are highly soluble in water and go deeper in the soil, below root zone, causing their temporary deficiency. Other fruit losses are enlisted below:

- Cherry: Fruit cracking
- Papaya: Papaya is susceptible to fungal root diseases. Killing of waterlogging plants.
- Pineapple: It requires good drainage. Excess moisture may cause the yellowing of the leaves followed by redness and it reduces the length.
- Mango: It reduces root dry weight, resulting in an increased shoot to root ratio, reduced net carbon dioxide assimilation rates.
- Apple: Water logging results in severe injury to the root system. Tree roots in waterlogged soils stop growing, minerals are not absorbed, leaves turn yellow and remain small, and finally roots begin to disinfections of phyto pathogen microorganisms in "wet-feet" conditions. Often, apple trees in poorly drained areas are infected by *Phytophthora* root and crown rot, slowly declining over one or more years. Fly speck, Sooty blotch, Water core, Fruit cracking and Fruit drop

Degradation of Pedosphere

On seasonal water logging, the prevailing land depicts shift of matrix colour from yellowish brown to olive brown, decay with inside the thickness and power of dependent B-horizons, growth in exchangeable Na and soluble salts with inside the floor horizons, fall of exchangeable divalent cations to exchangeable-Na ratio and a growth with inside the mobility of citrate–bicarbonate–dithionite extractable loose Fe and Mn. Seasonal water logging led to stages of degeneration, deterioration of dependent B-horizon and the dispersion of clays and soluble salts and their inconsistent downward movements with water desk front.

CONCLUSION

Considering the seriousness of the problem, following management measures can be undertaken to counter the water logging problems. (1) Installation of sub-surface drainage system or gravity drain for low lying

area (2) crop diversification to low water requiring crops (3) Practise of micro irrigation system (4) lining of canals (5) on farm water management

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