

PARTICULATE MATTERS EFFECT ON MAIZE POLLINATION, FOOD SECURITY AND HUMAN HEALTH

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ABSTRACT

Maize (*Zea mays* L.) is a short photoperiodic C₄ crop. It affects atmospheric carbon dioxide level and en-rich O₂ from plant population. Maize crops are more O₃ exposure elevated significantly and decline grain yields due to inactive pollen grains in heavy sunlight. The elevated CO₂ significantly increased the leaf area index, chlorophyll content and photosynthetic capacity. Airborne particulate matters (O₃, CO, NO₂, SO₂, Pb) are a born particle of the atmosphere that inactivates pollen grains of maize crop and affecting maize grain yield from fertilization during *Rabi* season. These particulate matters affecting also food securities and human health along maize crop grain yield. This article is providing a view of maize crop grain yield and food securities from particulate matters under field condition.

Keywords: Airborne particulate matter, Maize, Pollination, Yields and Health.

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Introduction

Particulate matter (PM) is a solid-liquid particle in the air. Solid particle of air having different sizes from 0.7–1 mm that accumulated by coagulation of ultra fine particles. Air particles are more distributed from road, traffics air environment about 58–68% (Wrobel, 2000). Combustion, mining, cooking, smoking, vehicles, and industrial emissions human activities are major causes of air pollution origin. These pollutants are originated to different sources of stationary and automobile industries in urban areas (Mishra et al., 2019). A complex chemical structure is generated to the environmental solid and liquid matter and generated into atmospheric matters like O₃ and NO₂ (Morillas et al., 2016). The atmospheric

pollutants deposited onto different flora and fauna of earth by accumulating rain, snow, and fog droplets. Most pollutants are also remaining either in small particles of the soil and water (Liu et al., 2020). Urban road soil or dust are mostly pollutant originate by inorganic particles or heavy metals (Pb, Cd, Cr, Ni, Zn, Cu, etc.) which direct influence on human health as it can easily enter into human bodies from inhalation, dermal contact and dust ingestion. Previous report observed that heavy metals easily deposit in fatty tissues of human and affecting different problems in the body due to endocrinal system disrupting (Duzgoren-Aydin, 2007). Such type creates carcinogenic, terato-genic and mutagenic disease in the body tissues of human. The C, O, Al, Si, K, Ca, Fe and Ni are generated in the troposphere due to human activity and create soil pollution. These carbon particles are more releases to diesel exhaust by vehicular emissions in India (Pachauri et al., 2013) and affected our environment by deposition on surface soil. This PM is following types:

(a) Ozone (O₃)

O₃ is environmental gases create from the joining of two oxygen atom under high electric condition. It is a strong oxidant about 52% stronger than chlorine gas. O₃ is creating in stratosphere by a chain of photochemical smog in the troposphere. It is reform from carbon assimilation and reduces growth of maize crop from act to natural environment in different soil micro flora (Alexopoulos et al., 2017).

(b) Carbon Monoxide (CO)

The incomplete combustion of fossil fuels is more generate carbon monoxide in stratosphere. The contacting of carbon monoxide to human lungs causes headache, dizziness and producing weakness, nausea, vomiting due to losses consciousness in normal people. CO is bind greater from haemoglobin than oxygen and causes poisoning condition. The high levels of CO loss of oxygen from competitive binding of CO and creates hypoxia, ischemia, and cardiovascular disease in long duration. The insufficient amount of CO is produces green houses gases and creates global warming condition in India. The global warming condition is increases soil and water temperatures in any area of weather (Emberson et al., 2017).

(c) Nitrogen Di-oxide (NO₂)

NO₂ is a traffic-related pollutant and created from automobile motor vehicles. NO₂ concentration is increases over 0.2 ppm amount due to T-lymphocytes and Natural Killer cells property change to which it produces adverse effects in human body (Richmont et al., 2017). This condition observed from disturbing immune system of our body. Often first produces eye, throat and nose irritation in men from increasing NO₂ in our environment. It also causes different respiratory diseases, coughing, wheezing, broncho-spasm and produces pulmonary edema from inhalation more amount of NO₂ after binding to lungs alveoli (Chen et al., 2007). It is emerging chronic lung disease after long term exposure of high levels NO₂ and also reduces maize crop leaf growth.

(d) Sulfur Di-oxide (SO₂)

SO₂ is generated from incomplete consumption of fossil fuel. It is a harmful gas that releases from industries and affects human, animal, and plant life. SO₂ is produces chronic

lung disease in children and old people which living near industrial zone. Men are feeling irritation, bronchitis, mucus production and broncho-spasm after infection in respiratory system. Infected person's skin showing redness and it damages mucous membranes of eye. SO₂ is annually produces 0.03 ppm. It is pre-existing symptoms of cardiovascular disease (Chen et al., 2007). SO₂ produces acid rain and causes acidification of the agricultural soils.

(e) Lead (Pb)

Pb is more using industrial heavy metals that generated from petrol engines, batteries, radiators, waste incinerators, and waste waters. Pb pollutants are mostly produced from metals, ore, and piston engine aircraft in Industry. It is enter in body from inhalation, ingestion, and dermal absorption and produces more toxic effects on the foetus and damages nervous system from brain swelling (NIH; 2017). Pb is accumulates in the blood system, soft tissue, liver, lung, bones, reproductive systems, cardiovascular and nervous system and produces chronic muscles and joint pain. Farhat et al (2017) reported children's are mostly suspected from Pb in metro cities. The children's are suffer to learning disabilities, hyperactivity and mental retardation. High amount of leads are showing harmful effect on maize crop growth rate.

The glumes of spikelet of the floret are designed to express anthesis to which a successful promotion create in pollination but also environmental heat stress lightly decreases spikelet tolerance from male gametophyte development. The maize ear is wrapped to multiple layers of husk. The maize husk leaves are control about 2-3 °C temperature inside from the outside temperature of the ear to which it easily situated in the middle section of the maize crop (Wang et al., 2023). The major objectives of the present article is entitled "Impact of Particulate Matter on Pollination Diversity and Food Security in maize crop" which assesses different pollutants associated with soil surface contamination and losses maize yield due to pollination shock.

Particulate Matters effect on Maize Crop pollination

Maize is popular form of 'cereal queen' name, it is cultivated whole year in India due to higher yield potency and easily grow under different soils and minimum moisture condition. Maize is a field crop and, its pollen grain is highly sensitive to heat during fertilization. Minimum effect of heat stress (About 2 week) is greater affects kernel number in per ear than pre-silking stage of stress during silking stage (Liu et al., 2022). Maize pollen grain is larger from 80-125 µm in diameter which easily spread in any crop environment from wind flow. Silk emerging is an important property of maize crop which occurs only some days in whole plant life of maize; it easily influences to high temperature during flowering time of maize crop to which decreases seed settlement on maize cob. Wang et al (2020) recorded some experiment of maize under control environment and explain 5 days of pre-silking environmental stress (3-4°C) reduced 10% maize seed set (22-32°C), whereas 5-days post-silking environmental stress reduced seed set by 23%.

Biologically a pollen grain is releases active lipids, air pollutants that modify pollen allergens through interaction of other spores. These air pollutants bind to allergens and create allergic disorders in men. Maize pollen grains are showing some protection against some air pollutant but it not fully active in dry environment. D'amato et al (2007) a data recorded

(Table 1) from the polluted field and recover to the control pollutant level. The pollutant is affected more to sample site and flowering of maize crop. Song et al. (2022) observed economic condition of maize crop yields due to climate change. It is grown about 150 m/ha in irrigated soils and contributes 36% global production. Atmospheric CO₂ increases photosynthesis, dry matter production, and yields in maize crop due to transpiration and rate of stomata conductance and increases water-use efficiency.

Waongo et al. (2015) reported that the temperature increase annually about 2°C from CO₂ to which reduces maize crop yield in eastern India. Higher level of CO₂ increases water demand and increases biomass in maize crop production. Several studies also found that higher atmospheric CO₂ is affect maize crop than less nutrient stress crops under high nutrient enrich environment. The impact of change annual temperature on maize crop yield and stem growth is quite sparse. Armentia et al (2017) collected allergens from different samples of maize and recorded morphological condition of pollination. In vitro and in vivo more number of pollens allergens is recorded from urban areas than rural areas. The polluted sites are shows higher number of allergens of pollen that more contribute to conformational transformations than post translational modifications.

Particulate Matters effect on Maize crop grain yield

Global yield of maize crops is down from seasonal increasing temperature during flowering condition from excess releasing CO₂. Therefore, CO₂ carrying crop resilience is not increase O₂ level. Annually increasing CO₂ is maize yield declines about 7.4% in the major cropping systems due to climate change and low rainfall in India (Ainsworth and Long, 2020). Temperature is meteorological determinant of maize crop development; it alters enzyme function in a leaf and triggers changes in developing stage of maize crop that tightly coupled with crop yield. The metabolic function is increases from increasing temperature and catalytic activity increases by Rubisco carboxylation. The Rubisco oxygenation ratio is increasing plant temperature and releases more 2-phosphoglycolate in photo-respiratory system and losses of previously stored carbon. The Rubisco is decreases ratio of carboxylation with the help of oxygen and decreases of flowing plant system temperature (Walker et al., 2016). CO₂ is collected more around Rubisco in C₄ cycle of chloroplast bundle sheath. Now, activation of photorespiration is down from increasing temperatures and maize crop can absorb more temperature than C₃ crop. The aeration and soil condition is also more help in the absorption of environmental temperature. It catalysing oxygenation of RuBP therefore Rubisco is a bi-functional enzyme in capturing environment CO₂ (Bathellier et al., 2020). Thus temperature is a limiting factor for C₄ photosynthesis and inactivation of Rubisco by C₄ bundle sheath enzymes. Maize is multi environmental crop that grow in different temperature and yield is less (0.8- 1.2%) affected during *Kharif* season; but exposure of particulate matter (PM) on maize crop yield is total losses. PM is deposit in maize crop leaf during early vegetative stage of life and yield losses in harvesting stage. Maize crop yield is also decreases to exposure of PM to which stomata blockage, and necrosis create during leaf let stage that decline yields (5-10%). Few studies and extant literatures are exploring intricacies of PM and dust deposition on maize leaf at road side due to contribute in yield losses (Hatami et al., 2018). The PM is more produces from large-scale biomass burning and ammonium emissions with crop residue combustion.

The winter organic carbon is accounting up to 45% of the total PM with 25% contribution of burning biomass. The particulate matter is indirect effect to deposit aerosol matter on leaf and scatters it by photoreceptors that reducing energy and carbon fixing (Wang et al., 2019). Increasing leaf temperature of a crop variety is increase photosynthesis rate or halt photosynthesis. Some maize crop varieties is growing in more temperature and dust polluted area in many region of India but yield is slow such as highway region (Dubey et al., 2020). In this area mostly farmers used maize crop production as fodder purpose. The photosynthesis is slow in maize crop after blockage of adaxial leaf stomata and reduced gas exchange in tissue system. The PM is an insulator for increasing leaf temperature but it also reduces to rainfall and presence of moisture in air.

Particulate Matters (PM) effect of Food securities

PM is a regulatory factor for air pollutant and its effect recently identified in the maize crops. Maize is nourishes about 10% of the world's population, in absence of tryptophan million premature children's suffering from malnutrition (UNICEF, 2021). 98% population of the lower and middle-income person is suffering from malnutrition. Middle and lower latitudes areas are more affected from climate change. Increasing global temperature and air pollutions are facing risk for failure crop production in middle and lower latitudes areas (IPCC, 2022). O₃ is trice oxygen molecule and breaking down as double oxygen (O₂) in the lower atmosphere. The O₂ is easily acted to UV light and include in suns UV radiation. More sunlight is create vital effect in the formation of O₃ in troposphere and reduced actual form of sun light at the earth surface. PM and O₃ interaction is more important for study modification in maize crop physiology. More amount of O₃ is recorded from the state of New Delhi, Panjab, Hariyana, U.P., Bihar and some areas of Bengal. Normally PM is increases O₃ formation rate in the form of NO_x. NO_x is a type of factor for O₃ formation from photochemical interaction (Sicard et al., 2020). Many records proof that lower rate of NO_x is down and compressed MP from light interception by causing O₃ interaction.

Avnery et al (2011) observed that O₃ is creating a type of global risk on maize crop yield in the nearest year 2030. Maize crop cob length (cm) and grains number are reduced PM affected areas. Therefore PM will be produce food crisis in future. The exploiting of population was first problems and PM become second problems in food production according to our demand. So it is need for Indian formers to produce resistant Quality Protein maize (QPM) hybrid varieties like HQPM-1. The QPM hybrids are recorded better production in India (Achchhelal et al., 2020).

Particulate Matters effect on Human Health

Airborne PM consistence a heterogeneous mixture of solid and liquid suspension particles in air that chemical concentration is dissolve to moisture contact. PM is heart associated materials that increased or decreased heart-rate function with cardiac arrhythmias. After long time exposure it observed in the form of lung cancer and chronic pulmonary disease in urban area which causes mortality. The lung cancer is increasing (0.5%) as global incidence in a year. Such disease is caused with air pollutant that infects tissues of human lung. The PM is reduces the life span of the population about 8 months from the average duration (Krewski, 2009). Atmospheric air pollutants spread human health problems through

ammonia, hydrogen sulphide, pesticides, particulate matter and some agricultural air pollutants.

Agricultural air pollutants distribute to environment and climate change of Indian ecosystem by emission of greenhouse gas and aerosols. Agricultural air pollutants also contact to soil active nitrogen, eutrophication and acidification of agricultural soil and can endangered biodiversity. Inorganic ammonia is playing dangerous role in environmental crisis through interactions of different compounds in the atmosphere. Chemical constituents of PM are distributed through biological compounds and metals. Fang et al (2013) reported approximately 3% cardiopulmonary and 5% lung cancer deaths are observed from PM. The PM causes more dangerous to human health than ozone and also other common air pollutants (as carbon monoxide).

Conclusion

High quantity of CO₂ increases carbon uptake and yield of maize crop but increased amount of other PM is decline the nutrient content in maize crop due to exposure. The PM is decreases air quality of environment during *Rabi* season. Higher quantity PM is produces from road side soil than the residential soil. The road is produces high anthropogenic elements (Pb, Cd, Zn, Mn, and Ni) due to vehicular diesel and petrol exhaust. Physiochemical processes of maize crop is reduces to dust coating on leaf and movement of pollen grains. It decreases nutrient quality due to absorption of pollutant. In the recent forming system a responsibility of formers that to be select PM resistant maize crop varieties to which neither loss of grain yield and nor defect human health. Farmers become use to sprinkler irrigation for road side crop irrigation that wash dust particles of maize crop leaf and help in pollen grain transfer from anthers to silk.

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