



Biostimulant Potential of Organic and Inorganic Amendments to Alleviate the Drought Stress in Wheat Crop in Pakistan

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Abstract

Drought is one of the most harmful environmental factors that adversely affect the growth of economically important crops and global food security. Its prevalence is increasing worldwide as a result of global warming and about one-third of the world land area is prone to drought. Droughts are also common in Pakistan that affects the agriculture. Wheat is the most important cereal crop in all over the world, but in Pakistan its yield is much lower than other countries. So, under this scenario there is a need to develop environment friendly approaches to mitigate the effects of drought stress for sustainable agricultural productivity. Use of organic matter can enhance soil moisture holding capacity and allow penetration of plant roots to access soil moisture and nutrients for higher crop yield. So, it is important to keep soil organic matter at reasonable levels to preserve the healthy soil. Cow dung manure and press mud both are good source of organic matter that can enhance nutrients and water holding capacity of soil. Silicon application can also improve the plant resistance to water deficiency under drought. Hence, the combine application of organic and inorganic amendments may be considered a practical approach to stimulate the growth and biomass of wheat crop under drought stress.

Keywords: Climate Change; Drought Stress; Food Security; Organic And Inorganic Amendments; Biostimulants

Introduction

Drought is a major hazard for sustainable crop production worldwide due to extreme climate change and affects all the development stages of plants and reduces the nutrient uptake and utilization potential of plants [1,2]. The decreased precipitation and altered rainfall patterns as a result of climatic variations are instigating the periodic onset of droughts in the world [3]. A predicted temperature increase of 1.5-5.8°C till 2100 due to global warming will increase the drought incidence all over the world and demand for irrigation water by 10% till 2050 [4,5]. Under drought stress, the intake of carbon dioxide is diminished due to stomatal closure. As a result, inside the stomata the high concentration of oxygen produces reactive oxygen

species (ROS) by the partial reduction of oxygen. The high levels of ROS lead towards membrane dismantling and subsequently affect the respiration, photosynthesis and the overall growth of the plants [6,7]. Drought adversely affects the soil water accessibility, plant growth and productivity, causing economic losses and has become the most significant limiting factor to food security [8]. Nutrient bioavailability and uptake by plants can be obstructed in soil with low moisture level leading towards extensive decline in crop yields through detrimental effects on plant growth, physiology and reproduction [9,10].

Food demand is increasing with the increasing human population, but world's crop productivity is decreasing due to abiotic stresses especially drought [11]. In arid and semi-

arid areas of the world, drought is one of the important reasons of inadequate agriculture production [12]. Wheat is the most imperative cereal crop all over the world, but drought stress has severely affected 60% of wheat production in high-income countries and 32% in low-income countries [13]. In Pakistan, wheat is cultivated under arid to semi-arid regions and decline in the yield of wheat crop due to drought is very severe. The agricultural division plays a central role in the economy of Pakistan that contributes 18.9% to GDP. The wheat crop accounts for 14% of value-added in agriculture sector and provides 3% of the country's GDP. In Pakistan, wheat is grown by 80% of farmers on 9 million ha land that is about 40% of the country's total cultivated land. Therefore, wheat is the single most important food crop in Pakistan [14]. According to the economic survey of Pakistan 2016-17, 30% of the total farmed area of the wheat crop is irrigated with canal water, while 55% is irrigated by tube wells and other sources. But no water is accessible for the remaining 15%. The droughts of 1998-2003 were the most severe in the history of Pakistan. In the case of Punjab, 13 districts are considered as most susceptible areas to drought [15]. The normal wheat grain yield in Pakistan is 2379 kg ha⁻¹ that is very low due to drought as compared to other wheat growing states of the world [12]. So, there is a need to enhance the productivity of wheat crop under drought stress. The effects of drought on soil moisture and plant growth can be alleviated by organic amendments in soil that can enhance the level of organic matter in the soil consequently leading towards moisture conservation and plant nutrient accessibility [16,17]. Concentration of organic matter in Pakistani soils is 10 g kg⁻¹ that is low as compared to the optimum level of 25-30 g kg⁻¹ [18]. Soil organic matter enhances the water holding potential of the soil, provides nutrients and promotes proliferation and penetration of plant roots to access soil moisture and nutrients under drought stress [19].

Both cow dung and press mud are important sources of organic matter in Pakistan and can influence soil moisture-holding capacity and nutrient availability under drought stress [19,20]. Cow dung manure is acknowledged to provide adequate supply of organic matter in the soil with better soil physical and chemical properties and enhanced crop productivity [21]. The application of cow dung enhances the level of organic carbon in the degraded soils that can stimulate the activity of beneficial microorganisms as well as the fertility of soil by enhancing the bioavailability of nutrients and moisture to plants. Cow dung improves the texture of the soil, helps to preserve moisture content and improves the growth and yield of plants [22,23]. Press mud as an organic amendment used to improve soil fertility and plant growth because it is a rich source of important plant nutrients like organic C, N, P, K, Ca and Mg along with traces of micronutrients like Zn, Fe, Cu and Mn. Press mud improves crop productivity by enhancing soil moisture, water holding

capacity, aeration, structure and texture. So, the valuable effect of this organic matter for enhancing the soil fertility and consequently stimulating crop productivity is well well-known [20,24]. Silicon is a nutritive element that can be used to enhance crop productivity under drought stress [25]. Silicon application increases the production of antioxidants, photosynthetic rate and water use efficiency under water-deficit conditions in different crop species [26]. Hence, the combined application of organic and inorganic amendments can stimulate the growth and yield of wheat crop under drought stress.

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