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Short communication

Impact of elevated atmospheric CO_2 concentration on nutrient quality of different maize genotypes

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Elevated carbondioxide (CO_2) concentrations and temperatures under global climate change scenarios projected for coming decades could impact food crop quality. Carbon emissions related to human activities have been significantly contributing to the elevation of atmospheric CO_2 and temperature. More recently, carbon emissions have greatly accelerated, thus much stronger effects on crops are expected. Within the conditions expected for the next few years, the physiological responses of crops suggest that they will grow faster, with slight changes in development, such as flowering and fruiting, depending on the species. There is growing evidence suggesting that C3 crops are likely to produce more harvestable products and that both C3 and C4 crops are likely to use less water with rising atmospheric CO_2 in the absence of stressful conditions. Changes in food quality in a warmer, high CO_2 world are to be expected, e.g., decreased protein and mineral nutrient concentrations. Studies related to changes in food quality as a consequence of global climatic changes should be priority areas for further studies, particularly because they will be increasingly associated with food quality and security. Hence, there is a need to understand the effects of these environmental factors on nutrient quality parameters of edible part of the crop.

An Open Top Chambers (OTCs) experiment was conducted at Central Research Institute of Dryland Agriculture (CRIDA) Hyderabad, The seed material of the maize genotypes DHM-117, Varun and Harsha were obtained from DMR Regional station at Hyderabad and raised in OTCs at ambient (390ppm) and elevated (550ppm) CO_2 levels during Rabi 2012. The open top chambers (OTCs) having 3m x 3m x 3m dimensions lined with transparent PVC (polyvinyl chloride) sheet having 90% transmittance of light were used. The elevated CO_2 of 550ppm was maintained in two OTCs and other two OTCs without any additional CO_2 supply served as ambient chamber control. The CO_2 concentrations within the OTCs were maintained and monitored continuously throughout the experimental period as illustrated by Vanaja *et al*. (2006).

Every chamber had 6 plants of each genotype planted in two rows of 1.0m with 0.35m spacing within row and 0.75m between rows. The recommended dose of fertilizers applied @ 60 kg N ha^{-1} and 60 kg P ha^{-1}, 30 kg K ha^{-1} as muriate of potash as basal dose; second dose of 30 kg N ha^{-1} at knee- high stage and third dose of 30 kg N ha^{-1} and 30 kg potassium ha^{-1} was side dressed at tasseling stage. The crop was irrigated at regular intervals and maintained pest and disease free with plant protection measures.

Food crop quality analysis of maize crop was undertaken for estimation of different nutrient proximates grown under elevated CO_2 treatment at comprising ambient and 550 ppm CO_2 treatment. Three genotypes of maize, i.e., DHM 117, Harsha and Varun were grown in OTCs in duplicates and after harvesting, the edible portion of maize grain were subjected to determine different phytochemical parameters and effect of elevated atmospheric CO2 concentration as compared to ambient conditions on nutrient quality of three different maize genotypes was studied. Determination of quality parameters was analysed with standard methods to compare the nutrient profile minerals iron, zinc, copper, manganese, magnesium, total ash (total mineral content) and protein was analysed by micro-jeldal method (Dhyan Singh *et. al.,* 2005), Crude fibre (Fibertech method), 100 seed weight was studied. All analysis was carried out in triplicates and the results were calculated on dry weight basis. Analysis of variance was carried out as described by Snedecor and Cochran (1989).

Protein content of elevated maize grain

The response of different phytochemical content to elevated carbondioxide concentrations in three different maize crop genotypes i.e., DHM 117, Harsha and Varun showed mixed results.The protein content (%) of Harsha

Table 1: Nutritional proximates of different genotypes of Maize grown under ambient and elevated CO_2 concentrations grown in OTC during 2012

Nutrient quality	DHM 117		Harsha		Varun	
	Ambient (Mean±SD)	eCO_2 (Mean±SD)	Ambient (Mean±SD)	eCO_2 (Mean±SD)	Ambient (Mean±SD)	eCO_2 (Mean±SD)
Protein (%)	11.68±0.68	11.9±0.19	10.01±1.83	8.66±0.69	9.68±0.32	12.04±0.37
Ash (%)	0.67±0.17	1.34±0.21	0.77±0.10	1.17±0.03	0.55±0.07	1.20±0.35
100 seed weight (g)	13.19±0.51	18.13±1.14	11.045±0.91	17.09±2.01	20.82±0.85	21.98±2.23
Zinc(mg/100g)	5.03±0.19	3.22±0.19	4.38±0.42	2.35±0.35	5.02±0.55	3.74±0.53

genotype of maize was significantly higher ($P<0.05$) compared to DHM 117 genotype at 550 ppm elevated CO_2. Varun variety found to contain significantly higher ($P<0.05$) protein content compared to Harsha variety at elevated CO_2 level (Table 1). The most influential factor in reducing grain nitrogen concentration was determined to be low soil nitrogen and under these conditions atmospheric CO_2 enrichment further reduced grain nitrogen and protein concentrations, although the change was much less than that consumed by low soil nitrogen. When soil nitrogen was not limiting however, increases in the air CO_2 concentration did not affect grain nitrogen and protein concentrations (Leimball *et.al.*, 2001). Literally thousands of studies have assessed the impact of elevated levels of atmospheric CO_2 on the quantity of biomass produced by agricultural crops, but only a tiny fraction of that number have looked at any aspect of food quality. From what has been learned about protein substances that have been investigated in this regard, however, there is no reason to believe that these other plant constituents would be present in any lower concentrations in a CO_2 enriched world of the future than they are currently. Indeed, there is ample evidence to suggest they may well be present in significantly greater concentrations, and certainly in greater absolute amounts. (Idso, *et al*, 2003). The effects of atmospheric CO_2 enrichment reported on plant constituents of significance to human health by Idso and Idso (2001) cited a number of studies that indicated elevated levels of atmospheric CO_2 may at times increase, decrease or have no effect upon the protein contents of various foods..

Physical quality of maize grain

DHM 117 genotype showed significantly higher ($P<0.05$) 100 seed weight at 550 ppm CO_2 as compared to ambient concentration of CO_2. The 100 seed weight of Varun genotype was found to be significantly higher ($P<0.01$) as compared to DHM 117 at ambient levels and 550 ppm CO_2 concentration. Harsha genotype was found to contain significantly higher ($P<0.01$) 100 seed weight grown at 550ppm as compared to ambient concentrations. The mean 100 seed weight of varun genotype was found to possess significantly higher seed weight as compared to Harsha genotype grown under both ambient and 550 ppm CO_2 (Table 1). Elevated levels of atmospheric CO_2 have also been determined to increase the crude fibre content and total ash is supported by Vanaja *et.al.*, (2007) where the response of total biomass of blackgram consumed an increased overall.

Mineral quality of maize grain

Total ash content (g/100g) of DHM 117, Harsha and Varun genotypes grown at 550ppm CO_2 was significantly higher ($P<0.05$) as compared to 390 ppm. Zinc content (mg/100g) of DHM 117 recorded significant increase ($P<0.05$) in DHM 117 genotype grown in chamber control as compared to enriched 550ppm CO_2. DHM 117 and Varun genotypes found to contain highly significant ($P<0.01$) zinc content as compared to Harsha grown at ambient conditions (Table 1).

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