An Empirical Analysis on Reaction of Seed Produce and Its Components of Red Gram (Cajanus Cajan) To Increased Co_2

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Abstract* – *Pigeon pea (Cajanus cajan L. Millsp.) is an important grain legume crop of the semi-arid tropics and is a major dietary protein source. The extra short duration cultivar of pigeon pea ICPL 88039 was evaluated at ambient (370 |imol/mol) and twice the ambient (700 |imol/mol) concentrations of CO_2 in open top chambers (OTCs). The results showed that the crop recorded a significant positive enhanced response for total biomass, fodder yield, grain yield, number of pods and seeds per plant, test weight and HI at elevated CO_2. The ANOVA revealed significant differences in response of the characteristics to CO_2 concentrations. Under elevated CO_2 the total biomass recorded an improvement of 91.3%, grain yield 150.1%, fodder yield 67.1%. The major contributing components for improved grain yield under elevated CO_2 were number of pods, number of seeds and test weight which recorded an increase of 97.9%, 119.5% and 7.2%, respectively. The crop maintained a significant positive increase of harvest index (HI) at elevated CO_2 with an increment of 30.7% over ambient values. This increase in HI was due to its improved pod set and seed yield under enhanced CO_2 concentration thereby emphasizes this crop for sustained food with nutritional security under climate change scenario.

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INTRODUCTION

Food grain prerequisites of India (both human and steers) are evaluated at 300 Mt in 2020 (Sinha et al. 1998). With the disturbing expand in Greenhouse gases (GHG) fixation and its normal effect on atmosphere, the issue rising might be to attain the focused on generation. To address the above issue from the agricultural perspective, it is attractive to select the harvests and their cultivars thereof, that can better use the expanded amassing of Co2 for both biomass and grain yield. Dissimilar to other non-leguminous C3 plants, just legumes have the possibility to augment the profit of raised Co2 by matching animated photosynthesis with expanded N2 fixation (Rogers et al. 2009). If there should arise an occurrence of food legumes where grain is collected for human utilization, the interpretation of expanded biomass more towards grain or enhanced harvest list requirement to be accomplished for breaking the yield obstructions of these exceptionally essential C3 grain legumes predominantly developed in the minimized rainfed ranges. India is the biggest maker and shopper of beats on the planet. India develops beats in around the range of 22.5 million hectare and 80 for every penny is in dry ranges. On the other hand, beats preparation has been stagnant between 11 and 14 million tonnes throughout the most recent two decades. For every capita beats utilization throughout the years lowered from 61 g/day in 1951 to 30 g/day in 2008 (Amarender Reddy 2009). Lifted Co2 condition seems to enhance the in general development of plants as a rule and may bring about progressions in parceling of photosynthetic assimilates to different plant organs after some time.

Pigeon pea is an indeterminate pulse crop mainly grown during monsoon season for food, feed and soil fertility. An attempt was made in this paper to quantify the response of pigeon pea- major rainfed grain legume crop to increased atmospheric CO2 concentration in terms of yield and its components to know the response of not only the grain yield but also to find out the most important yield contributing characteristics. The outcome of this study is useful to the crop improvement programs, which enable the overall productivity increase of this important grain legume for nutritional security of the vast majority of semi arid rainfed ecosystem of the drought prone areas of the world including Afro-Asian underdeveloped and developing nations.

MATERIALS AND METHODS

Parameters	2008		2009	
	eCO_2	aCO_2	eCO_2	aCO_2
Temperature (°C)				
Minimum	19.0	17.9	16.6	16.5
Maximum	38.8	38.4	40.2	38.0
Average	27.55	26.1	28.3	25.8
Relative humidity (%)				
Minimum	18.0	25.27	16.6	29.6
Maximum	91.7	93.54	87.8	87.7
Average	61.9	67.2	61.1	66.3

Table 1. Chamber temperature and relative humidity of [eCO2] and [aCO2] for the crop during 2008 and 2009.

The seeds of the extra short duration grain legume pigeon pea cv. ICPL 88039 were sown in open top chambers (OTCs) of 3 x 3 m diameter lined with transparent PVC (polyvinyl chloride) sheet, which had 90% transmittance of light. The study was conducted during monsoon season (June to September) of 2008 and 2009 at the Central Research Institute for Dryland Agriculture, Hyderabad, India. The seeds were sown directly in the soil (alfisol) within the OTC's. The crop was evaluated at two CO2 concentrations, i.e. 370 mol/mol (aCO2) and 700 ^mol/mol (eCO2) and two OTCs were maintained for each CO2 concentration. Two OTCs were at aCO2 without any external CO2 supply and served as ambient control. The elevated concentration of CO2 (eCO2) were maintained throughout the 24 h a day from sowing to final harvesting. To maintain the eCO2 in OTCs, i.e. 700 |mol/mol at crop canopy level, continuous injecting of 100% CO2 from a compressed CO2 cylinder into plenum of OTCs was done where it was mixed with air from air compressor before entering into the chamber. The air sample from each chamber was drawn from the center point of OTCs at three-minute interval into non-dispersive infrared (NDIR) CO2 analyzer (California Analytical) and the set CO2 concentration was maintained with an automatic switching solenoid, rotameters, Program Logic Control (PLC) and Supervisory Control and Data Acquisition (SCADA) software (Vanaja et al. 2006a).

The experimental site was sandy loam in texture, neutral in pH (6.8), low in available nitrogen (225 kg/ha), phosphorus (10 kg/ha) and medium to high in available potassium (300 kg/ha). For the two years of study with pigeon pea cv. ICPL 88039, seeds were obtained from the ICRISAT, Patancheru, Hyderabad and every year fresh seeds were sown. The crop was raised in OTCs following recommended agronomy practices and crop was maintained free from moisture stress, pests and diseases. The crop received 828.6 mm and 566.4 mm rainfall during the years 2008 and 2009, respectively, distributed in 30 rainy days (A day is 'rainy' with more than 2.5 mm rainfall). The temperature and humidity within the OTCs with aCO2 and eCO2 were presented in Table 1.

The pigeon pea harvest was gathered at 120 days. Five replications with fifteen plants for every replication in every Co2 fixation were reaped and utilized for recording biomass, grub yield, grain yield and its segments viz., unit number, seed number and 100 seed weight. Howdy was ascertained as (grain yield)/(total over the ground dry mass).

The information were factually broke down utilizing a two-route examination of fluctuation (ANOVA) to test the centrality of variability between the qualities, Co2 fixations and their co-operations.

RESULTS AND DISCUSSION

The response of pigeon pea to two concentrations of CO2 namely 370 |mol/mol (ambient) and 700 |mol/mol (elevated) were studied in terms of total biomass, grain yield, fodder yield and the harvest index (HI). The ANOVA revealed significant differences for the characteristics and CO2 concentrations (Table 2). From this analysis it is also evident that the magnitude of response of different characters was different with increased CO2 concentration.

Source	*df*	Mean sum of squares
Replications	4	43625**
Characteristics	7	125406**
CO_2 concentrations	1	76724*
Characteristics × CO_2 concentrations	7	18529
Error		11671
SE ±		
Characteristics		34.16
CO_2 concentrations		17.08
Characteristics × CO_2 concentrations		48.31

*significant at 5% level; "significant at 1% level

Table 2. ANOVA for various characters at [aCO2] and [eCO2] in pigeon pea

Absolute biomass (grams for every plant). In pigeon pea, the sum biomass enhanced from 61.1 g/pl at encompassing to 116.9 g/pl under raised Co2 (Figure 1), subsequently indicating a change of 91.3% (Figure 2). In mung bean, Das et al. (2002) reported that the bio- mass reaction to lifted Co2 condition at introductory development stages was higher (55%) as compared with later development arranges (8%). At raised Co2 condition, the expanded photosynthesis in all C3 plants bring about expanded plant biomass and the reaction of nitrogen settling legumes is higher compared with other non leguminous C3 crops (Vanaja et al. 2006b, Rogers et al. 2009). This could be because of the unaffected leaf N levels of lion's share of legumes under lifted Co2 condition (Winkler and Herbst 2004).

The limit for legumes to organize improved osmosis of C and N at lifted [co2] to stay away from down-regulation of photosynthetic limit and at last amplify picks up in profit has been showed over an extent of animal categories, environmental conditions, and ecological settings (Ainsworth and Rogers 2007, Leakey et al. 2009).

Fodder yield (grams for every plant). The fodder yield enhanced from 43.3 g/pl. at aco2 to 72.3 g/pl. by eCo2 (Figure 1), indicating an addition of 67.1% with eco2 (Figure 2). Legumes are so receptive to air Co2 enhancement that they really build in richness inside blended neighborhoods. Campbell et al. (2000) discovered that the vegetable substance of grass-vegetable swards expanded by in the vicinity of 10% according to a multiplying of the air Co2 content, which would at last make more nitrogen accessible to the environment's non-leguminous plants.

Grain yield (grams for every plant). The grain yield enhanced from 17.8 g/pl at surrounding to 44.6 g/pl at 700 |mol/mol (Figure 1), in this way indicating an addition of 150.1% with eCo2 (Figure 2). At twice-encompassing convergances of environmental Co2, Palta and Ludwig (2000) recorded 52% and 55% expansions in dry matter and seed yield, individually, in restricted leafed lupin. In mung bean a noteworthy builds in unit number, case weight and sum seed weight were accounted for at lifted Co2 focus (Ziska and Blowsky 2007).

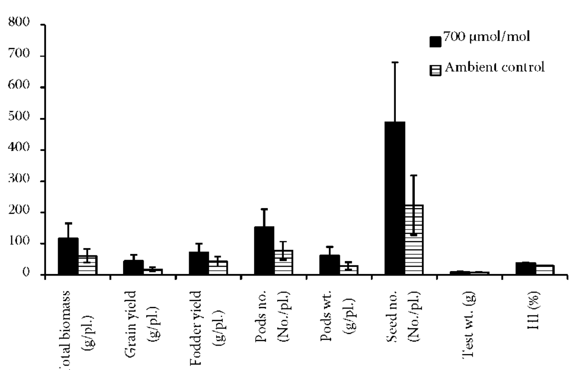

Figure 1. Per se values of total biomass, fodder yield, grain yield, its components and HI for pigeon pea at [aCO2] and [eCO2]

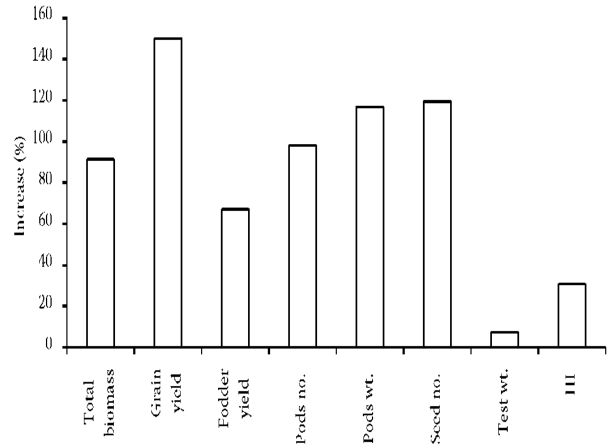

Figure 2. % increase of total biomass, fodder yield, grain yield, its components and HI for pigeon pea with [eCO2]

Number of pod for every plant. The pod number for every plant indicated an increment of 97.9% over ambient chamber control i.e. a two fold esteem as that acquired at aCo2 revealing to it to be a vital yield helping segment with eCo2. The bloom to unit change and maintenance of blossom and in addition units in beats is delicate to abiotic burdens like dampness, temperature and nutritional hassles there by reduction in sink size bring about reduced grain yield. In the present study it was obviously obvious the upgraded centralizations of Co2 essentially enhancing the amount of units and seeds making as higher grain yield.

Number of seed for every plant. A quite high reaction of 119.5% expansion in number of seed over ambient control was watched at eCo2, indicating more than two fold expand in the worth. This demonstrates the character vitality in yield expand and also its reaction to eCo2, along these lines careless, on yield helping character that is to be laid in the product change program. The improvement of seed preparation was unequivocally corresponded with the upgrade of seed nitrogen for every plant under raised Co2 which was initiated by expanded N procurement throughout the conceptive period. Vegetable species have a tendency to gain more N and transform a greater number of seeds at hoisted Co2 than non-nitrogen settling species (Miyagi et al. 2007).

Test weight (g). The test weight recorded an expansion of 7.2% over the ambient control suggesting that the reaction under eco2 was moderately low for this character as compared to number of cases and number of seeds. The addition in test weight with eCo2 could be because of more filled seed as opposed to augmentation in weight of filled seed. Advancing seeds can speak to a vast carbon sink for the plant and raised Co2 can likewise prompt heavier seeds (Darbah et al. 2008). Expanded carbon assignment to seeds could be matched by corresponding supplement distribution, bringing about no change in the seed supplement content, as is regularly the case in legumes (Miyagi et al. 2007).

Harvest record (%). The yield kept up a critical positive expansion of HI at eCo2 i.e. from 29.2% HI at aCo2 to 38.2% (Figure 1), therefore indicating an addition of 30.7% over ambient qualities (Figure 2). This was the resultant of a proportionate equivalent augmentation in aggregate biomass and likewise grain yield under eCo2. Along these lines this product may be worth stressing for food sustenance with nutritional security under environmental change situation. Also, the effects which are in tune with long ago reported discoveries by Vanaja et al. (2007) uncovered a critical expand in the HI because of their enhanced apportioning effectiveness under eCo2 condition. Enhanced Co2 reduced to zero the amount of cases that had little seeds (> 30-80 mg) and reduced the amount of units with unfilled seeds from 16 to 1 pod/plant in limited leafed source-constrained lupin (Palta and Ludwig 2000). This expanded seed yield for every plant by 44-66%, yet finished not influence the harvest list.

An increment of 97.9% for number of pods/plant by eCo2 over ambient control and 119.5% for number of seeds/plant, while for test weight it was 7.2%. The above effects show that the increment in grain yield (115.1%) with eCo2 was fundamentally because of the expansions in the yield parts viz., number of cases and number of seeds.

The grain legumes are one of the pillar of the drylands as these harvests furnish quite required nutritional security as proteins to the substantial garbage of predominant veggie lover populaces of India and additionally the world. The present effects demonstrate that their imperativeness under environmental change situation could additionally maintain as all the yield parts and also the HI have demonstrated huge expand under lifted Co2. Separated from enhancing the dirt through their root nodulation impact (soil health sustenance) they are additionally known to enhance the nutrition of creatures (fodder) and people (protein) (Kretschmer and Pitman 2001). The recharging of supplements, particularly the N to the dirt through grain legumes might be a help as the rained/dry lands are parched as well as ravenous. Crop turn is one of the agronomic standards in agriculture. Grain legumes could be an extremely significant part of harvest pivot for their capacity in soil building procedure with stress on soil ripeness, separated from being food and nutrition asset.

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