



CRIDA 18R, a new horsegram (*Macrotyloma uniflorum*) variety: germination as influenced by higher CO₂, temperature and relative humidity*

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Received: 5 May 2011; Revised accepted: 18 June 2012

Key words: CO₂, Germination, Horse gram, *Macrotyloma uniflorum*, Temperature and RH

Horsegram [*Macrotyloma uniflorum* (Lam) Verdic] is an arid legume with multi utility. It is known for its ability to reclaim wastelands is a nutritious human food and animal feed as well as its immense medicinal value, especially against kidney stones as mentioned in ayurveda (Kumar 2006). Lipid fraction in certain foodstuffs had a protective effect which was most marked in the lipid obtained from horse gram (Jayaraj *et al.* 2000). It is mainly grown as a late rainy season crop and hence an excellent contingent crop.

A new brown seeded horsegram variety CRIDA-18R was developed by Central Research Institute for Dryland Agriculture and released by Central Varietal Release Committee (CVRC) in 2009 for South India (Raghu Ram Reddy *et al.* 2010). It has higher-yielding ability of both grain and fodder, with high carbohydrate and protein content in the seed along with its ability of non-shattering of pods and tolerant to pests and diseases namely yellow mosaic virus, powdery mildew and mites. In recent on-farm trials, this CRIDA-18R variety yielded 59% more as intercrop with *Jatropha* and 40% more as a sole crop than local variety in farmer's fields of Andhra Pradesh (CRIDA 2008–09).

In the present scenario of global climate change which is much influenced by higher CO₂, it is imperative to investigate the crop germination and growth under various levels of CO₂ and response change with varied temperature ranges. Changes in CO₂ and associated changes in global

temperature can cause significant changes in the crop production. The CO₂ levels are expected to increase by 550 and 700 ppm by 2020 and 2050 respectively. Average global temperature increased by 0.6°C in the 20th century (Folland *et al.* 2001) and it is predicted to increase between 1.7°C and 4.9°C by the year 2100 (Cubasch *et al.* 2001). Hence an attempt was made to assess the influence of enhanced atmospheric CO₂ on horse gram variety CRIDA-18R germination at different temperatures.

The seeds of horse gram variety CRIDA-18R were sown in open top chambers (OTCs) at two enhanced levels of CO₂, viz. 550 ppm and 700 ppm and compared with ambient chamber control (380 ppm). In order to assess the germination at various temperatures and humidity levels, the crop was sown at four different dates during 2010, 7 January (D1), 27 January (D2), 11 February (D3) and 26 February (D4) at all CO₂ levels.

The experimental site was sandy loam in texture, neutral in pH (6.8), low in available nitrogen (210 kg/ha), phosphorus (10 kg/ha) and medium to high in available potassium (170 kg/ha). The plants were raised in open top chambers (OTCs) having 3 m × 3 m × 3 m dimensions lined with transparent PVC (polyvinyl chloride) sheet having 90% transmittance of light. At 2.4 m height of each chamber a frustum with an angle, 0.6 m towards inside was maintained to reduce the dilution effect of the air current within the chamber. Two OTCs were maintained as replication for each elevated concentration of CO₂. The set concentration of CO₂ was maintained in each chamber at crop canopy level by continuously injecting pure CO₂ into plenum of the OTCs where it was mixed with ambient air from air compressor before entering into the chamber. The two OTCs maintained at ambient CO₂ level (380 ppm) without any external CO₂ supply served as chamber ambient control. The air sample from each chamber was drawn at 3 minutes interval into non-dispersive infrared (NDIR) CO₂ analyzer (California

*Short note

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Analytical) and the set concentration of CO₂ was maintained with the help of solenoid valves, roto meters, personal computers (PCs), Program Logic Control (PLC) and Supervisory Control and Data Acquisition (SCADA) software. Throughout the experimental period continuous measurement of relative humidity and temperature of all the OTCs was possible with the sensors fitted inside the chambers.

The seeds of horsegram variety CRIDA-18R were sown in 1 m × 1 m plots with an inter row spacing of 25 cm and intra row spacing of 10 cm in each of the four dates of sowing. One week after sowing, the observation on % of germination was recorded by counting the number of emerged seedlings in each plot of different treatments.

It is interesting to note that each of the four dates showed a similar trend of highest % of germination at 700 ppm (99%) followed by 550 ppm (84%) and ambient (76%) (Fig 1). The temperature was highest at 700 ppm, followed by ambient and lowest being at 550 ppm. The RH was lowest at 700 ppm, followed by ambient and highest being at 550 ppm (Fig 2). This trend was seen in each of the four dates of sowing. The results showed that at 550 ppm lowest temperature and highest RH was seen while at 700 ppm highest temperature and lowest RH was observed showing

that at each date the temperature and RH were negatively linear with each of the CO₂ levels. However ambient control showed average temperature and average RH.

This revealed that as the CO₂ concentration increased from ambient control, there was a corresponding linear increase in percentage of germination with a raise of 8% on an average from ambient to 550 ppm and 15% from 550 ppm to 700 ppm (Fig 1). The per cent of germination at all dates of sowing improved by 9 to 24% at higher concentration of CO₂ over ambient control. The impact of increased CO₂ concentration was maintained from D1 to D4 though the average relative humidity decreased by 4.7% and temperature increased by 3.6°C.

Among the four dates of sowing, D4 recorded highest temperature with lowest RH (%). However D1 recorded a vise versa results with lowest temperature and highest RH. These results indicate that the temperature and RH were showing a negatively linear trend among these two important components of climate on different dates of sowing. However, different dates of sowing had no significant effect on the per cent of germination. This reveals that percentage of germination was not affected by variability in the temperature and RH.

The better response of percentage of germination at elevated CO₂ is a positive indication that under climatic change scenario with predicted variable temperature and relative humidity the impact on horsegram will be minimum.

The studies of Vanaja *et al.* (2006) clearly indicated that percentage of germination, speed of germination, emergence index and vigour index were positively increased by elevated CO₂ level of 600 ppm in blackgram by (*Vigna mungo* L. Hepper) and an increase of 5.2% in germination at 6 DAS was observed at elevated CO₂. However, Zebian and Reekie (1998) reported that neither the time required reaching 50% germination nor final germination was affected by CO₂ in *Medicago*, *Gypsophia* and *Sinapis* grown in three different light regimes. The actual mechanism behind the effect of elevated CO₂ on germination and emergence is unknown. The possible impacts could be small seeds have greater

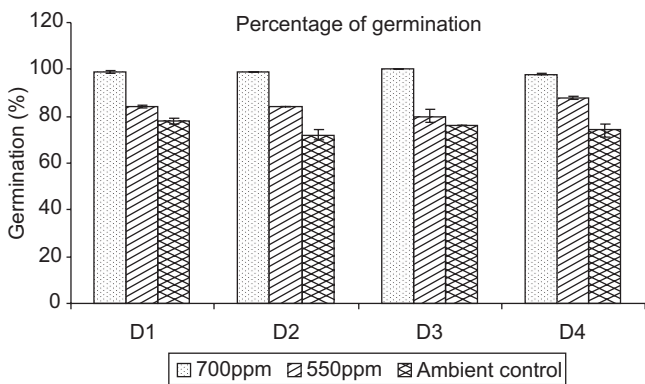


Fig 1 Percentage of germination in horsegram CRIDA 18R at various levels of CO₂ and four dates of sowing

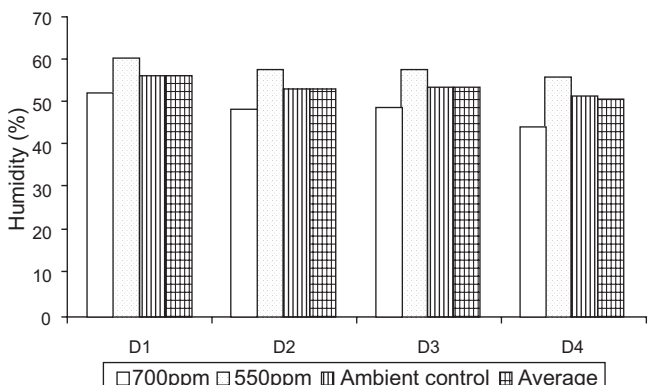
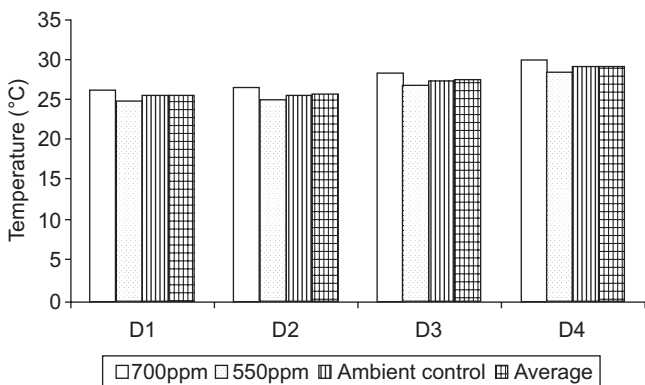


Fig 2 Average temperature and relative humidity (%) at different dates of sowing of horsegram CRIDA 18R

surface to volume ratio and hence a greater diffusing capacity for CO₂ (Ziska and Bunce 1993) or elevated CO₂ levels may stimulate the internal ethylene production (Esashi *et al.* 1986). Ziska and Bunce (1993) were speculating that the influence of the elevated CO₂ in stimulating the germination and emergence might be due to ethylene.

SUMMARY

The better response of horsegram germination percentage to elevated CO₂ is a positive indication as this particular crop being thermo and photo-sensitive in nature at ambient field level. The higher concentration of CO₂ may play ameliorating role to offset the negative effects of variable temperature and relative humidity under climatic change scenario.

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