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# Changes in Nitrogen and Dry matter Accumulation in Pigeon Pea under Drought and During Revival

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The prominent effects of soil moisture stress on crop plants are reduction in plant growth, changes in various physiological processes (Turner & Begg 1981, Nandwal *et al.* 1991) and N fixation (Venkateswarlu *et al.* 1989). While in legumes, water deficit has been shown to affect total accumulation of N (De Vries *et al.* 1989), the influence of drought and revival on N status and dry matter is not well documented in different plant parts. Therefore the present investigations were taken up to study the changes in the concentrations of total amino acids, proteins and N in different plant parts in relation to N fixation under drought and at the time of revival of stressed pigeon pea plants.

The crop of determinate pigeon pea (*Cajanus cajan* L. cv. ICPL-151) was grown in earthen pots (30 cm dia.) filled with 5.5 kg of sand, with the photosynthetic photon flux density of 1150±50 $\mu$ mol $m^{-2}$ $s^{-1}$ and 1020±30 $\mu$ mol $m^{-2}$ $s^{-1}$ at the mean temperature of 39±2°C and 36±1°C at vegetative and flowering stages respectively. Drought was imposed by withholding the irrigation at vegetative and flowering stages i.e. 35 and 65 days after sowing and samplings were done immediately at the time when the sensor (PT- 51-05 of Dewpoint Microvoltmeter, HR-33T, Wescor, Inc., USA) showed soil Ψ w of -0.77 MPa (moderate stress) and soil Ψ w of -1.34 MPa (severe stress), corresponding to soil moisture content (SMC %) of 5.5 and 3%, respectively. The control plants were maintained at soil Ψ w of -0.37 MPa and SMC of 10 %. Half of the severely stressed plants were reirrigated on the same day when they were showing the soil Ψ w of -1.34 MPa and sampled after two days to observe the recovery at the same soil Ψw as that of control. Specific nitrogenase activity (SNA) of nodules was determined using Acetylene reduction assay (ARA). The plants were separated into leaves, stem, root and nodules and dried in oven at 85°C to a constant weight. Free amino acids (FAA), protein and total N were estimated according to the method of Yemm and Cocking (1955) after extracting in 80% Folin Phenol reagent (Lowry *et al.* 1951) and by micro-Kjeldhal's method, respectively. Analysis of available N of soil was done by Subbiah and Asija (1956). In all four replications were used to analyse the critical difference at 5 % level of significance.

A significant decrease in dry weight of leaves was obtained at soil Ψ w of -1.34 MPa and during recovery. Dry weight of root and nodule significantly increased at soil Ψ w of -0.77 MPa due to translocation of more photosynthates (Nandwal et al. 1991). A similar pattern of dry matter accumulation per plant was observed (Table 1). Specific nitrogenase activity (SNA) was enhanced significantly at soil Ψ w of -0.77 MPa at both the stages, however decreased sharply to 91 and 88 % at soil Ψ w of -1.34 MPa. The recovery was 30 and 70% at these stages on reirrigation. A decrease in SNA under soil Ψ w of -1.34 MPa was accompanied by a concomitant decrease in nodule dry matter. A significant increase in FAA of nodule was noticed at soil Ψ w -1.34 MPa. Though there was a decline in FAA of plant components after revival, yet the values were significantly higher compared to the control. The increase or decrease of FAA of severe stress level was found to be linked to the protein breakdown or synthesis in different plant parts. Changes in nodule protein were similar as reported in leaf under drought, however, after revival, further decrease in nodule protein was observed.

Soil Ψ w -0.77 MPa significantly increased the leaf and nodule-N, but reduced at Soil Ψ w -1.34

**Table 1** *Effect of drought on dry weight (g), nitrogenase (μ mol $C_2H_4$ $g^{-1}$ nodule) and FAA, protein and nitrogen (mg $g^{-1}$) in Pigeon pea*

| | Vegetative | | | | CD | Flowering | | | | CD |
|---|---|---|---|---|---|---|---|---|---|---|
| | Soil Ψ w (−MPa) | | | | 5% | Soil Ψ w (−MPa) | | | | 5% |
| | 0.37 | 0.77 | 1.34 | 0.37(R*) | | 0.37 | 0.77 | 1.34 | 0.37(R) | |
| Plant DW | 4.97 | 5.20 | 4.37 | 4.02 | 0.17 | 6.09 | 6.45 | 5.58 | 5.11 | 0.27 |
| Nodule DW | 0.15 | 0.19 | 0.12 | 0.09 | 0.04 | 0.20 | 0.29 | 0.15 | 0.12 | 0.08 |
| Nitrogenase activity | 34.0 | 42.5 | 3.09 | 10.2 | 4.3 | 25.9 | 34.6 | 3.2 | 18.6 | 2.9 |
| FAA leaf | 3.7 | 4.7 | 8.6 | 5.6 | 0.5 | 9.5 | 6.5 | 9.4 | 8.0 | 0.6 |
| FAA root | 3.0 | 3.5 | 6.5 | 4.8 | 1.0 | 3.4 | 2.7 | 5.3 | 3.6 | 0.2 |
| FAA nodule | 11.9 | 11.0 | 15.0 | 12.5 | 0.7 | 7.9 | 8.0 | 9.4 | 8.4 | 0.5 |
| Protein Leaf | 128.4 | 148.4 | 83.2 | 94.2 | 7.4 | 138.6 | 104.9 | 91.6 | 97.9 | 7.9 |
| Protein Root | 87.3 | 71.9 | 32.4 | 26.5 | 8.7 | 82.6 | 69.6 | 40.3 | 26.8 | 8.9 |
| Protein Nodule | 156.0 | 173.9 | 106.8 | 85.4 | 10.2 | 144.0 | 116.8 | 107.6 | 95.5 | 9.5 |
| Leaf−N | 24.4 | 30.7 | 28.3 | 28.6 | 0.6 | 34.0 | 35.1 | 30.1 | 30.8 | 0.6 |
| Stem−N | 19.6 | 17.0 | 22.8 | 18.4 | 0.7 | 27.2 | 25.0 | 21.7 | 18.9 | 1.4 |
| Root−N | 22.1 | 18.2 | 16.8 | 15.4 | 1.1 | 25.2 | 23.1 | 22.5 | 19.3 | 0.7 |
| Nodule−N | 44.0 | 50.4 | 37.2 | 39.1 | 1.8 | 41.0 | 45.0 | 37.7 | 39.1 | 2.8 |
| Total−N Plant$^{-1}$ | 113.7 | 122.3 | 92.8 | 90.2 | 8.1 | 180.7 | 185.3 | 141.1 | 124.4 | 10.1 |
| | Available soil nitrogen (mg N $kg^{-1}$ soil) | | | | | | | | | |
| | 64.0 | 71.0 | 87.0 | 61.0 | 6.4 | 39.0 | 50.0 | 91.0 | 65.0 | 6.2 |

R* – Revival.

MPa at both the stages. Nodule-N and total N were enhanced significantly at soil Ψ w -0.77 MPa, because of high SNA. At vegetative stage soil Ψ w -0.77 MPa significantly reduced stem-N, but it was enhanced at soil Ψ w -1.34 MPa. At flowering stem-N decreased significantly with rise in level of drought. Root-N declined significantly under drought at both the samplings. The N content further declined after revival. Decrease in total dry matter accumulation was due to abscission of leaves and secondly might be due to the increase in respiration (Hooda *et al.* 1990). In revived plants, stem and root N decreased and this might be due to their utilization for the re-growth of the plant, which was stopped at soil Ψ w -1.34 MPa.

The higher content of available N in soil was observed at vegetative stage than at flowering in control. After revival, soil N decreased rapidly. This increase in soil nitrogen under drought was due to a change in the permeability of roots and nodules.

Finally, it is concluded that cv. ICPL-151 can stand well at soil Ψ w of -0.77 MPa and the increase in dry matter of different plant parts and of total plant, in relation to protein content, N content of plant parts and total plant nitrogen at soil Ψ w of -0.77 MPa, confirms the earlier findings of Chapman & Muchow (1985) that N accumulation is closely related to the dry matter accumulation. The recovery in shoot was better than underground plant parts.

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