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ASSIMILATE PARTITIONING IN RESPONSE TO IRRIGATION IN SMALL AND BOLD SEEDED CHICKPEA VARIETIES

RAKESH PANDEY[1], POONAM SHARMA-NATU[2] AND M.C. GHILDIYAL[2]

[1]Project Directorate for Cropping System Research, Modipuram, Meerut-250110
[2]Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi-110012

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SUMMARY

Chickpea (*Cicer arietinum* L.) var. Pusa 256 (bold seeded) and Pusa 261 (small seeded), raised under unirrigated and irrigated field conditions, were examined for Rubisco, soluble protein and N contents in the leaves in relation to yield and harvest index (HI). Bold seeded variety showed a lesser decrease in HI and greater mobilization of vegetative N compared to small seeded variety. Furthermore, higher soluble protein content in the leaves of deflowered plants mimicked a response similar to that of irrigation treatment. The present study, therefore, provided additional evidence in support of the observation that a decrease in HI under irrigated condition is due to suppression of flowering. A basis for selection of irrigation responsive varieties which would show less reduction in HI under irrigated condition was indicated.

Key words: **Chickpea, harvest index, irrigation, leaf nitrogen, rubisco, soluble protein**

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a major pulse crop grown in India. This crop, like most of the grain legumes, is grown in relatively dry land of low fertility with extremely low levels of agronomic management, hence, yield remained low (Jain 1988). It was therefore, suggested that for a major production advance and to overcome instability in production of pulses some management support in terms of irrigation etc. needs to be provided (Jain 1988). However, it has been a common observation that excess availability of water through irrigation or winter rains at the time of flowering promotes vegetative growth (Saxena 1984). Irrigation after flowering, does not generally maximize chickpea yield under north Indian condition as it increases vegetative growth and decreases harvest index (Singh 1991, Nanda and Saini 1992, Sinha 1995, Krishnamurthy *et al.* 1999). It is therefore, important to select irrigation responsive varieties which would maintain reproductive growth and higher harvest index under irrigated condition.

It was reported earlier that the decrease in harvest index (HI) by irrigation was due to suppression of flowering and pod number (Pandey 1998, Pandey *et al.* 2001). This led to decreased requirement of dry matter and N in the reproductive sink and consequently more of dry matter and N was retained in the vegetative tissues (Pandey *et al.* 2001, Sharma-Natu *et al.* 2003). Considering these observations, a decrease in sink strength by flower and pod removal should mimick a response similar to that of irrigation treatment. Furthermore, if decrease in HI by irrigation was due to a decrease in sink strength through decrease in pod number, then a variety having bolder seeds should show lesser decrease in HI by irrigation than small seed type. The present study attempted to analyse these questions using small and bold seeded cultivars of chickpea.

MATERIALS AND METHODS

Chickpea (*Cicer arietinum* L.) cvs. Pusa 261 (small seeded) and Pusa 256 (bold seeded) were grown under unirrigated and irrigated field conditions. Fertilizers were applied to the soil at the rate of 15, 60 and 60 kg ha^{-1} of N, P and K, respectively. Seeds were inoculated with *Rhizobium* culture prior to sowing. Plant to plant spacing was maintained at 30 cm between rows and 12 cm within rows. A presowing irrigation was applied to the entire field. The irrigation treatment consisted of two additional irrigations applied at the flowering and pod filling stages. There was no significant rain during the flowering period in the chickpea crop. The first flower appeared around 90 days after sowing (DAS) and more than 50% of flowering had taken place by 105 DAS. Irrigation at the flowering and post flowering stages were applied at 105 and 125 DAS. Sample for leaf N, soluble protein and Rubisco content were taken 132 DAS (post flowering). At maturity, data on dry weight of plant parts, seed yield, number of pods (expressed as per m^{-2}), seed number per pod, 100 seed weight and harvest index (%) were recorded. One m^2 sample (32 plants) was taken as one replication. There were three replications for each determination. The data were analysed statistically by analysis of variance (ANOVA). In another study field grown irrigated chickpea plants were deflowered/depodded so that pods were not allowed to develop. The soluble protein content in the leaves of control and deflowered plants was determined 15 days after the treatment.

The total N content was determined in the dried leaf samples using a Kjeltec auto 1028 analyser (Tecator, Hoganas, Sweden). Soluble protein content was determined by method of Bradford (1976). The soluble proteins were then separated by sodium dodecylsuphate-polyacrylamide gel electrophoresis (SDS-PAGE) (Laemmli 1970, Servaites *et al.* 1984). The gel was scanned using a laser densitometer (LKB Ultrascan XL, Pharmacia, Sweden). The bands were quantified by measuring the integrated areas of the corresponding bands. The Rubisco content [large subunit (LSU) + small subunit (SSU)] as a percentage of the soluble protein was thus determined.

RESULTS AND DISCUSSION

Chickpea var. Pusa 256 is a bolder seed type and has 100 seed weight around two times to that of var. Pusa 261 (Table 1). Pod number m^{-2} and seed yield m^{-2} were decreased whereas shoot + pod cover weight m^{-2} was increased significantly in both the varieties under irrigated condition. No significant effect on seed number pod^{-1} was observed. Both the varieties also showed a decrease in harvest index by irrigation. The decrease in HI by irrigation was 42.45% in Pusa 261 and 29.99% in Pusa 256. Var. Pusa 256 having bolder seeds was, therefore, found to show lesser decrease in HI under irrigated condition compared to small grain var. Pusa 261. The HI of Pusa 256 was higher than Pusa 261 under both unirrigated and irrigated conditions but the difference was more under irrigated condition. The Rubisco content, soluble protein content and N content in the leaves were higher in irrigated

Table 1. Yield components of chickpea varieties grown under unirrigated and irrigated field conditions.

Variety	Treatment	Pod number m^{-2}	Seed number pod^{-1}	100 seed weight (g)	Seed yield ($g\ m^{-2}$)	Shoot + pod cover weight($g\ m^{-2}$)	Harvest index (%)
Pusa 261	Unirrigated	1742	1.19	13.20	274.76	566.56	32.65
	Irrigated	1258	1.14	10.60	152.04	657.04	18.79
	Mean	1500	1.16	11.90	213.40	611.80	25.72
	CD at 5% P	281	NS	1.48	78.12	40.00	5.81
Pusa 256	Unirrigated	1629	0.91	24.21	359.89	567.42	38.81
	Irrigated	1207	0.90	21.41	233.69	626.41	27.17
	Mean	1418	0.90	22.81	296.79	596.91	32.94
	CD at 5% P	281	NS	2.56	113.13	46.00	5.23
	CD at 5% P for var.mean	NS	0.13	1.23	57.09	NS	3.43

compared to unirrigated plants (Fig. 1). Pusa 256 was found to have lower content of soluble protein, Rubisco and leaf N, compared to Pusa 261 under both unirrigated and irrigated conditions. The plants where pods were not allowed to develop by deflowering/depodding treatment, showed a higher content of leaf soluble protein in both the varieties (Fig. 2.).

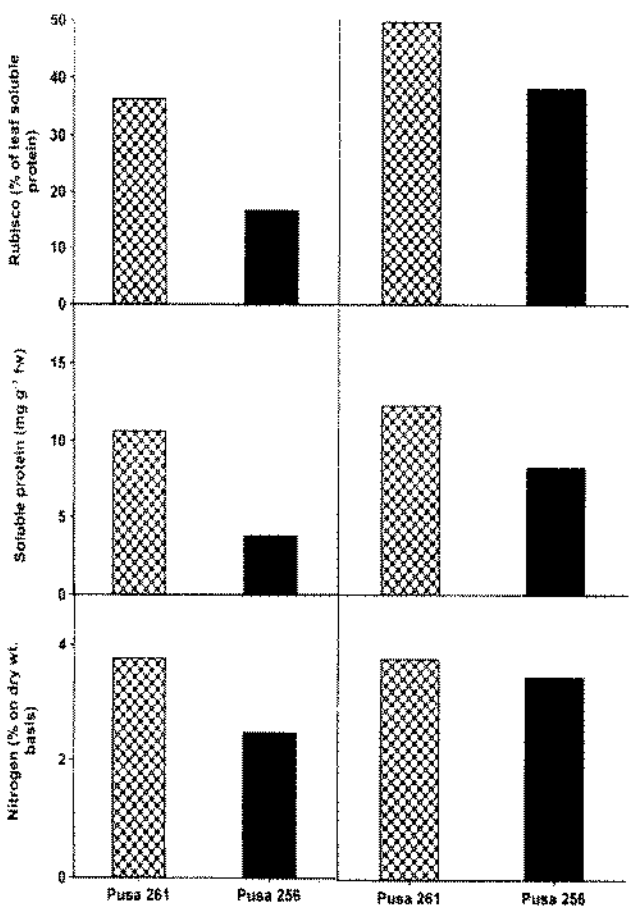

Fig. 1. Contents of Rubisco (LSU+SSU), soluble protein and nitrogen in the leaves at post flowering stage in chickpea varieties grown under unirrigated and irrigated field conditions

In the present study, bold seeded var. Pusa 256 showed a lesser decrease in HI compared to small seeded var. Pusa 261 under irrigated condition. The decrease in HI by irrigation has been reported to be due to suppression of flowering and pod number. This led to a decreased requirement of dry matter and N in reproductive sink. Consequently, more of dry matter is retained in vegetative

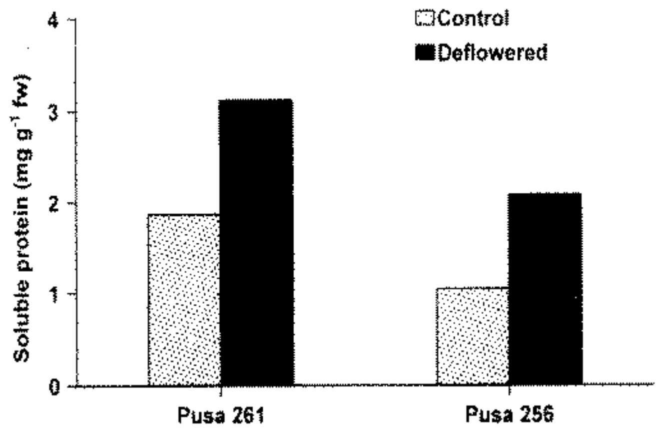

Fig. 2. Soluble protein content in the leaves of control and deflowered chickpea varieties at pod filling stage

tissues (Pandey *et al.* 2001, Sharma-Natu *et al.* 2003). Since, pod number decreases under irrigated condition, a variety having potential for bolder seeds would sustain relatively greater requirement of dry matter and N. The lesser decrease in HI in bold seeded variety than small seeded one observed in the present study is therefore, in line with the above concept.

Chickpea being a protein rich grain legume accumulates large quantities of N in seeds. Since, the N requirement is not met by current sources of N, vegetative N, particularly leaf N, is mobilized for seed development in grain legumes (Sinha and Ghildiyal 1971, Sinclair and DeWit 1975, Evans 1982, Ghildiyal and Sirohi 1986, Ghildiyal *et al.* 1987, Mitra and Ghildiyal 1988, Singh 1990). Hooda *et al.* (1990) observed that in chickpea about 55-58% of the seed N requirement was met by mobilization from vegetative parts, leaves contributed 39% of seed N. The mobilization of vegetative N is therefore, of considerable significance for seed yield in chickpea (Sinha 1995).

It was reported earlier that leaf nitrogen including Rubisco is mobilized during pod development in chickpea and irrigation decreases this mobilization (Pandey *et al.* 2001). A decrease in acid protease activity has been found to be associated with the decrease in N mobilization by irrigation (Sharma-Natu *et al.* 2003). The decrease in protease activity by irrigation was postulated to be regulated through hormonal signal from sink. In the present study, bolder seed type sustained the requirement of N relatively more than small seeded variety, consequently, there was a greater mobilization of leaf N and Rubisco in bolder seed variety. These observations, therefore, bring out that when reproductive sink is decreased by irrigation due to suppression of flowering,there is a decrease in leaf N mobilization and more of N is retained in the leaves. This is what has been observed also in deflowered/depodded plants. Infact deflowered/depodded plants mimicked a response similar to that of irrigation treatment.

The present study therefore, provided additional evidences in favour of the suggestion that decrease in HI under irrigation was because of decrease in reproductive sinks as a result of suppression of flowering by irrigation. The physiological basis of suppression of flowering by irrigation in chickpea, however, is not clear. Irrigation has been shown to delay flowering in chickpea (Saxena 1984, Haloi and Baldev 1986, Johansen *et al.* 1994). Photosensitivity of chickpea varieties has also been shown to be affected by soil moisture status (Wasnik *et al.* 1986). The possible role of 29 and 42 kDa polypeptides, which are also decreased by irrigation, on flowering in chickpea has been postulated (Pandey *et al.* 2003). How to overcome the suppression of flowering and consequent pod number by irrigation in chickpea, is a matter of future investigation. The present study however, indicates that bolder seeded variety would show a lesser decrease in HI and a relatively better response to irrigation than small seeded variety.

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