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The protein content of chickpea (*Cicer arietinum* L.) grown at different locations

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Abstract. Seed protein content was determined in several genotypes of chickpea grown at different locations in India in different years. Statistical analysis showed that locations had the greatest influence on seed protein content. The effects due to cultivars although significant were of low magnitude. Cultivars × location interactions were found to be nonsignificant and there were good correlations among locations suggesting that breeding for improved seed protein content in chickpea could be effectively carried out at a single location.

Introduction

Seed proteins are of prime significance in human and animal nutrition. In order to harvest more protein of improved quality, genetic improvement of seed proteins has attracted considerable attention. Environment plays an important role in the determination of quantity and quality of seed protein in food crops. The effects of environments on protein quantity and quality in cereal crops have been extensively investigated by several workers [1, 2, 3]. Several attempts have been made to study the effect of environment on seed protein content in grain legumes. The interaction of genotype and environment on protein content in pulses were reported earlier [4, 5]. Bliss et al. [6] studied the effect of different environments on yield and protein and amino acid content of mature cowpea seeds and they observed that genotype × location components for seed size and percent protein were large and statistically significant. Wood et al. [7] reported statistically significant location effects on available methionine and proteins in beans (*Phaseolus vulgaris*). Further, they also observed that the cultivar × location effect was not significant and suggested that selection of cultivars for high available methionine could be practised at one location for all breeding programmes.

There is little information concerning environmental effects on seed protein quantity and quality in chickpea (*Cicer arietinum* L.). Cultivaral differences have been reported for seed protein and amino acid contents [8]. Location effect was relatively more important than that of cultivar effect on the crude protein and amino acid contents of chickpea [9]. This

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paper reports a study of the variation in seed protein content in chickpea across locations in India and discusses its significance in relation to breeding for increased protein content.

Materials and methods

Experiments were conducted in two seasons in a randomized complete block designs with four replications and a plot size of 4 rows of 3 m length in different agroclimatic zones of India [10]. In 1975–76, forty seven cultivars of chickpea were grown during the post-rainy season at four locations: ICRISAT Center, near Hyderabad; Jabalpur, Hissar and Pantnagar. In 1977–78, 25 desi (light brown testa angular seed) cultivars were grown at Hissar, New Delhi, Ludhiana and Berhampore and 15 kabuli (salmon white testa, ram's head shaped seed) cultivars at Hissar, Ludhiana and New Delhi. Whole seed samples were collected from each plot and ground to a fine powder in a Udy cyclone mill using 0.4 mm screen. The nitrogen content of the finely ground whole seed samples was determined by a rapid procedure of Technicon auto analyser described by Singh and Jambunathan [11] and converted to protein by multiplication by 6.25.

Results and discussion

Different locations and agroclimatic regions of India where chickpea trials were conducted are shown in Table 1. There were large and highly significant differences in seed protein contents among locations in all three data sets (Table 2). In 1975–76 (Table 3), protein contents ranged between 18.2 and 22.4 percent, with the highest value recorded at Pantnagar and the lowest at Hissar. In 1977–78, the seed protein contents of both desi and kabuli cultivars were highest at Ludhiana and lowest at New Delhi. The 1977–78 data agree with Dodd and Pushpamma [9] who observed that mean protein content of 11 chickpea cultivars was highest at Ludhiana. Krober [5] reported the lowest protein content for all pulses including chickpea when grown at Hyderabad. Some Hyderabad soils are saline which can reduce protein content markedly [12] and this may account for low values of protein observed at that location.

Differences among cultivars were significant but small compared with those among location differences (Table 2). This is also indicated by very high percent of total sum of squares as compared to that by cultivars and cultivar x location. Mean squares due to the interactions between cultivars and locations were even smaller and significant only in the desi set in 1977–78. There were also significant rank correlations between the protein contents of cultivars at different locations. These observations agree with those of Wood et al [7] who reported statistically significant location effects on

Table 1: Monthly rainfall (R) (mm) and temperature (T) (°C) for locations where trials were grown

Year	Location	Latitude °N	Soil		Month						
					Oct	Nov	Dec	Jan	Feb	Mar	Apr
1975–76	ICRISAT Center	18	Black	R	173.5	15.0	0.0	0.0	0.0	0.5	91.0
				T	24.8	19.6	18.0	19.2	21.8	26.8	29.2
	Jabalpur	23	Black	R	129.6	0.0	0.0	8.4	0.0	12.7	1.5
				T	..... Not available						
	Hissar	29	Sandy	R	15.4	6.4	0.0	3.2	7.8	15.6	0.0
				T	25.0	17.5	15.6	13.5	16.0	19.5	28.5
	Pantnagar	33	Alluvial	R	7.6	0.0	0.0	1.0	43.6	6.0	0.0
				T	..... Not available						
1977–78	Hissar	29	Sandy	R	0.0	0.2	6.9	0.8	33.0	56.7	0.0
				T	25.7	20.9	16.2	11.8	13.6	20.0	26.1
	Ludhiana	31	Sandy	R	2.4	5.1	41.3	4.9	35.8	51.9	13.0
				T	24.8	24.8	14.3	11.2	13.2	24.2	25.1
	New Delhi	29	Alluvial	R	7.2	0.0	18.6	0.0	9.0	21.2	–
				T	25.0	21.3	16.9	14.3	15.0	21.1	–
	Berhampore	24	Loamy	R	151.7	31.6	28.0	1.5	29.4	30.5	36.4
				T	22.0	24.9	19.1	17.0	20.1	24.8	29.9

Table 2. Mean squares from analysis of variance of seed protein contents of chickpea of the cultivars grown at different locations in 1975–76 and 1977–78 seasons

Source	1975–76			1977–78					
				ICCT-Desi			ICCT-Kabuli		
	d.f.	Mean squares	% Total SS	d.f.	Mean squares	% Total SS	d.f.	Mean squares	% Total SS
Locations	3	172.12**	31.4	3	518.71**	59.1	2	186.07**	61.4
Cultivars	46	2.01*	5.6	24	15.00**	13.7	14	3.46**	8.0
Locations X cultivars	138	0.53	4.4	72	2.55*	6.9	28	1.44	6.7
Error	561	1.72	58.6	297	1.79	20.2	84	1.73	24.0

* Significant at 5% level; ICCT: International Chickpea Cooperative Trials
** Significant at 1% level.

Table 3. Means and ranges of whole seed protein contents of chickpea cultivars grown at different locations during 1975–76 and 1977–78.

Year	Location	Protein (%)		
		Range	Mean	SD[a]
1975–76	ICRISAT Center	16.1–22.1	19.5	1.04
	Hissar	16.1–19.4	18.2	0.64
	Pantnagar	20.7–24.4	22.4	1.35
	Jabalpur	19.3–23.0	21.4	1.28
1977–78 (Desi)	Hissar	21.3–25.5	23.2	1.04
	Ludhiana	24.4–28.5	26.6	1.70
	New Delhi	20.5–23.8	21.6	0.58
	Berhampore	20.4–27.1	21.9	1.27
1977–78 (Kabuli)	Hissar	20.1–24.7	22.6	0.84
	Ludhiana	24.9–30.3	27.7	1.68
	New Delhi	19.3–22.9	21.6	1.25

[a]Standard deviation of the location mean.

protein and available methionine in beans and suggest that breeding for increased protein content in chickpea could be based on selection in a single environment.

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