Indian J. Genet., 50(1): 71–75 (1990)

STABILITY OF PROTEIN CONTENT OF CHICKPEA (*CICER ARIETINUM* L.)

C. L. L. GOWDA, U. SINGH AND K. L. SAHRAWAT

International Crops Research Institute for the Semi-Arid Tropics
Patancheru, Andhra Pradesh 502324

(Received: July 30, 1988; accepted: March 15, 1989)

ABSTRACT

Variability in protein content of a given chickpea genotype has been a matter of concern to the chickpea breeders involved in breeding for high protein content. Therefore, stability of protein content is an important consideration. The present study has indicated that (i) protein content is influenced by variation in soil pH and EC, (ii) uniform and smaller experimental areas could be used for trials related to protein improvement, and (iii) there are genotypic differences for stability of protein content.

Key words: Chickpea, *Cicer arietinum*, stability, protein content.

Chickpea (*Cicer arietinum* L.), the most important pulse crop in India, has crude protein content in the seed in the range of 12.6%–30.5% [1]. Protein content in chickpea has been found to vary considerably over locations, although the interaction between locations and protein content was not significant [2]. Such variations may be due to edaphic and climatic factors. Large variation across seasons within a location may be attributed, to some extent, to the seasonal variations in climate, especially in rainfall and temperature. High soil salinity was reported to decrease protein content of chickpeas [3]. Application of nitrogen, phosphorus, and sulphur fertilizers improved the levels of both protein and essential amino acids in chickpea [4]. Instability of protein content greatly hinders efforts to breed chickpeas for high protein content. Therefore, this study aims to investigate further the magnitude and causes of such variation in protein content of chickpeas grown on vertisols at the ICRISAT Centre, Patancheru near Hyderabad (18°N, 78°E), India. A series of experiments were conducted during 1985–1987 to investigate the magnitude of variability in protein content of chickpea in the same and different seasons.

MATERIALS AND METHODS

Experiment 1. This experiment was carried out during the postrainy season of 1985–86. Annigeri, a common cultivar adapted to the warmer regions of peninsular India, was grown at five selected field locations at the ICRISAT Centre. Seed samples of cv. Annigeri were

harvested randomly from different parts of the five fields. Seed samples were ground to a fine powder, using the Udy Cyclone Mill. Protein content was determined using Technicon Autoanalyser [5]. The number of samples from different fields varied from 16 to 50.

Experiment 2. To find out the correlation of soil pH and EC (electrical conductivity) with seed protein content, an experiment was conducted during the postrainy season of 1986–87. Variety Annigeri was grown in two different fields at the ICRISAT Centre. Soil samples were taken from each plot where Annigeri was grown from three random places at three depths (0–15, 15–30, and 30–60 cm). The samples for each soil depth from three places were pooled to get one composite sample. Soil pH and EC were determined for each sample. The pH and EC were measured using a 1:2 soil to water extract. Soil pH was measured by a glass electrode and EC by an electrical conductivity meter [6]. After harvest, the seed samples were analysed for protein content as described earlier.

Experiment 3. This experiment was designed to test the stability of protein content of different cultivars. Fourteen chickpea genotypes were selected based on protein content measured over 3–4 years (from 1982 to 1986). Twelve of these were identified as high-protein lines (including check P 422), and two (ICC 2927 and Annigeri) as having variable protein content in different years. These 14 genotypes were planted in two different fields at the ICRISAT Centre during the 1986–87 postrainy season. The trial was laid out in randomized complete block design with three replications in each of the two fields. Soil samples were taken from each plot to determine pH and EC, as per the procedure mentioned for Experiment 2. The seed samples from each plot were analysed for protein content as described earlier.

RESULTS AND DISCUSSION

Experiment 1. The range and mean protein content of cv. Annigeri and soil characteristics in different fields in 1985–86 are presented in Table 1. The mean protein content in different fields varied in the range of 17.6%–22.9%. The variation for protein content

Table 1. Protein content of cv. Annigeri, and soil characteristics of the fields, ICRISAT Centre, 1985–86 (Experiment 1)

Field No.	Protein (%)		Soil characteristics	
	range	mean ± SE	pH	EC
1	16.3–19.7	17.8 ± 0.24	8.86	0.21
2	16.7–19.7	17.9 ± 0.18	8.65	0.27
3	21.9–23.8	22.9 ± 0.07	7.85	0.16
4	17.2–23.1	19.2 ± 0.21	8.51	<0.15
5	13.9–21.0	17.6 ± 0.24	8.08	0.20

was larger (13.9–21.0%) in the fields showing a lower mean protein content (e.g. Field 5), and was smaller (21.9–23.8%) in those with a higher mean protein content (Field 3). It seems that the fields having soil pH <8.5 and EC <0.15 give higher protein, while high soil pH (>8.5) and high EC (>0.20), alone or in combination, tend to give lower values of mean protein content. Similar effects of high pH and high EC reducing seed protein content in chickpea have been reported earlier [3].

Experiment 2. The data on seed protein content, pH, and EC for the two fields recorded during the 1986–87 season are presented in Table 2. The mean protein values in the two fields were 17.6% and 18.4%. The variation for protein content (range within a field) is 5–6% (Table 2). Although low in magnitude, there was a significant negative correlation between seed protein content and soil pH and EC. This means that high soil pH and EC adversely affect protein content in chickpea. This again confirms our earlier observations [3].

Table 2. Protein content of cv. Annigeri in two fields at ICRISAT Centre 1986–87 (Experiment 2)

Field No.	Protein content (%)		pH ± SE	EC ± SE	Correlation of protein (%) with	
	mean ± SE	range			pH	EC
6 (n=48)	18.4± 1.31	15.8–21.9	8.1± 0.07	0.3± 0.05	–0.33*	–0.11
7 (n=72)	17.6± 1.19	15.4–20.6	8.3± 0.11	0.3± 0.11	0.19	–0.31**

*,** Significant at 5% and 1% levels, respectively.

Regarding the large variation in protein content of a cultivar within a field, we hypothesize that it results from varying levels of pH and EC in different parts of a field. Such variation is larger in the samples from a larger field, and relatively less in smaller plots. Variability can, therefore, be reduced by smaller experimental areas, and by selecting uniform field by taking a cover crop of maize without N fertilization. Difference in growth will indicate variability in the field.

Experiment 3. At ICRISAT, we have analysed several thousands of germplasm accessions of chickpea during the last 10 years and have observed a large variation in protein content of these accessions. But some accessions such as P 422, ICC 2927, ICC 4106, ICC 10193, ICC 11036 and ICC 11072 have shown fairly consistent protein content over the years. These lines may be genetically tolerant to changes in soil pH and EC and merit further investigation.

The combined analysis of variance for the trials in two fields indicated that both, the fields and genotypes, differed significantly in protein accumulation. The interaction effect of genotypes with fields was nonsignificant. The correlation study indicated that protein content is mildly negatively correlated with pH (–0.243*) and EC (–0.310**). These correlations were of higher magnitude than those in Experiment 2, possibly because of high genetic variability of protein content in Experiment 3. The protein content recorded from the two fields is presented in Table 3. In general, the protein levels were lower in field 8 than in field 9. Individual values varied considerably across the six replications in two fields. The protein content varied among replications by a margin of 3.7–9.3%. This shows considerable variation in protein content within a given genotype. The average difference in protein content over replications was 5.7%. This value has been used to classify tentatively the germplasm as stable (with <5.7% difference) and unstable (with >5.7% difference). In this case, six lines are unstable for protein content, and the remaining eight lines can be considered as stable. Stability analysis in another study also indicated that some varieties are more stable for protein content than others [7].

Table 3. Protein content (%) of chickpea genotypes in two fields, ICRISAT 1986–87 (Experiment 3)

Genotype	Field 8	Field 9	Range	Difference*
ICC 2927	21.8	19.1	17.9–22.4	4.5
ICC 3273	25.3	20.4	19.6–26.8	7.2
ICC 3522	22.8	17.8	16.3–25.6	9.3
ICC 4106	20.8	18.4	18.1-21.8	3.7
ICC 10193	23.7	20.1	19.3–23.8	4.5
ICC 10658	21.9	19.6	19.0–25.0	6.0
ICC 11036	19.8	19.3	17.9–22.1	4.2
ICC 11042	22.4	19.0	17.9–23.5	5.6
ICC 11468	22.1	18.6	17.8–24.4	6.6
ICC 11087	22.2	18.2	17.6–22.9	5.3
ICC 11193	23.4	19.7	17.8–24.6	6.8
ICC 11072	21.9	20.2	18.6–23.3	4.7
P 422	21.3	20.3	19.4–23.1	3.7
Annigeri	20.4	16.1	14.4–21.6	7.2

* Difference between the lowest and highest protein content over six plots (i.e. three replications in each field).

Based on these studies, we conclude that some chickpea genotypes appear to be more stable than others with regard to protein content. This information would be useful for a breeding programme that intends to develop genotypes with improved protein content.

REFERENCES

1. U. Singh. 1985. Nutritional quality of chickpea (*Cicer arietinum* L.): Current status and future research needs. Qual. Plant. Pl. Fd. Hum. Nut., **35**: 339–351.

2. U. Singh, J. Kumar and C. L. L. Gowda. 1983. The protein content of chickpea (*Cicer arietinum*) grown at different locations. Qual. Plant. Pl. Fd. Hum. Nut., **32:** 179–184.

3. J. Kumar, C. L. L. Gowda, N. P. Saxena, S. C. Sethi, U. Singh and K. L. Sahrawat. 1983. Effect of salinity on protein content and seed size of chickpea. Curr. Sci., **52:** 82–83.

4. N. Gupta and R. S. Singh. 1982. Effect of nitrogen, phosphorus, and sulphur nutrients on protein and amino acids in Bengal gram (*Cicer arietinum* L.). Indian J. Agric. Res., **16:** 113–117.

5. U. Singh and R. Jambunathan. 1980. Evaluation of rapid methods for the estimation of protein in chickpea (*Cicer arietinum* L.). J. Sci. Food Agric., **31:** 247–254.

6. M. L. Jackson. 1967. Soil Chemical Analysis. Prentice Hall (India), New Delhi: 498.

7. J. P. Yadavendra and S. K. Dixit. 1987. Stability for seed protein in chickpea. Indian J. agric. Sci., **57:** 876–879.