Hyderabad and Varanasi (Tyagi *et al.*,1982[1]). But it is low yielding and small seeded. The F_2 generation of a cross of T-1-A and Annigeri and the parents were studied for their protein percentage, seed size, and flower color.

The F_1 flower color, like Annigeri, was pink. The F_2 plants segregated in a 3 : 1 ratio for pink and blue flower color (pink = 257, blue = 63, χ^2 = 4.82, P = 0.025-0.050) indicating single-gene segregation.

Blue flowered plants had higher seed protein percentages and smaller seeds than pink flowered plants (Table 1) indicating linkage between the genes for flower color, protein content, and seed weight. The ranges for protein percentage and seed size in blue and pink flowered plants overlap and the correlation coefficient between seed weight and protein content was -.743, indicating that the linkage is not tight and that, if larger populations are screened, segregants that combine high seed protein percentage and seed size may be recovered. In another note in this issue of the newsletter, Singh *et al.* suggest the existence of a mechanism in T-1-A that prevents starch accumulation, reducing seed size and increasing protein content. Further studies are required to investigate this and to establish whether it is simply inherited and easy to manipulate through breeding.

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[1]Tyagi, P.S., Singh, B.D., and Jaiswal, H.K. 1982. International Chickpea Newsletter 6:6-8.

High Seed Protein Percentage in Chickpea. II. Comparative Nitrogen Accumulation Patterns

At ICRISAT, chickpea seed protein has ranged from 12.4 to 31.0% among the chickpea germplasm collection so far screened. High protein lines are being used in the breeding program to develop high protein cultivars but tend to be small-seeded (Kumar *et al.*, 1982[1]). This study was undertaken in order to improve our understanding of the nitrogen accumulation pattern in the plant parts of high protein (T-1-A) and low protein (Annigeri) cultivars at different growth stages.

The cultivars were grown on Vertisols at ICRISAT Center during the post-rainy 1981/82 season. No fertilizer was applied but one irrigation was given at flowering. The soil pH, available nitrogen and phosphorus and organic matter content of the plots where T-1-A and Annigeri were grown were similar. T-1-A is a late cultivar and takes about 50 days to flower whereas Annigeri takes about 40 days to flower. Six randomly selected plants were sampled at 10 day intervals from flowering and dried at 65°C in the oven. The samples were ground in a Udy cyclone mill to a fine powder (60 mesh) and analyzed for nitrogen content using the Technicon auto analyzer (Singh and Jambunathan, 1980[2]). Soluble sugars and starch content were estimated according to Singh *et al.* (1980)[3]. The results reported are means of six plants.

The nitrogen contents of the roots and stems of the two cultivars were similar nor did they change with time. However, in Annigeri the nitrogen contents of the leaves progressively declined after flowering and there was considerable mobilisation into seeds (Figure 1). In contrast, in T-1-A, the nitrogen contents of the leaves increased up to 30 days after flowering and mobilisation into seeds was at a smaller rate and at 70 days after flowering was much lower than in seeds of Annigeri.

These changes were associated with similar patterns in soluble carbohydrates and starch contents. In Annigeri, the soluble carbohydrate contents of the leaves declined and there were marked increases in both the soluble carbohydrate and starch contents of the seeds. In T-1-A, soluble carbohydrates initially increased in the leaves and there appeared to be little accumulation of soluble carbohydrate and especially of starch, in seeds.

The seed yields of T-1-A were only one third of those obtained from Annigeri. Dry matter accumulation and nitrogen per plant were considerably higher in T-1-A than in Annigeri at most stages of growth, so the source was not limiting. Earlier studies have indicated that the sink becomes limiting only where seeds are very small (4.2 g/100) (Sheldrake and Saxena, 1979[4]). The lower yields, and the higher seed protein percentages of T-1-A than Annigeri may therefore result from defective carbohydrate metabolism reducing seed size by inhibiting starch deposition in the seed.

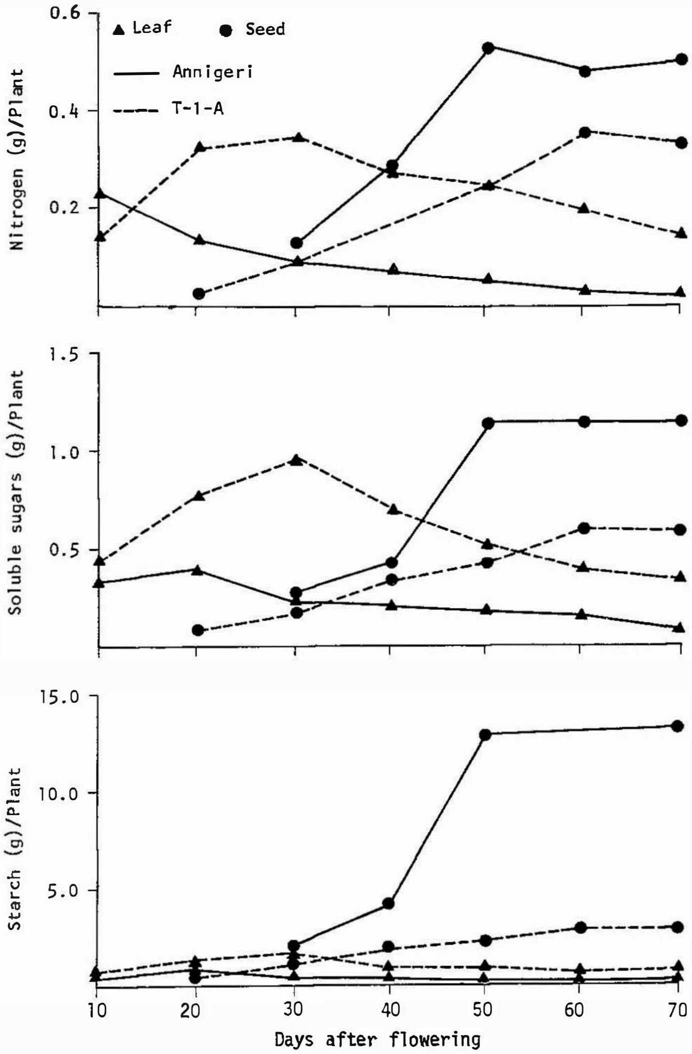

Figure 1. Total nitrogen, soluble sugars and starch content of leaf and seed of Annigeri and T-1-A at different stages of growth.

Further studies of these aspects are in progress.

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Economics

Chickpea in Kenya

Observations made during the 1982 season indicate that Kenya may be a much more important chickpea producing country than has been hitherto suspected. In June we observed an area of about 160 square kilometers on deep Vertisols near Masinga in Yatta Division of Machakos District where cultivators plant mainly a chickpea and maize (5 : 1 ratio) intercrop. In much of this area the maize had failed due to early cessation of rains but the chickpea was growing well and was heavily nodulated. A similar area lies near Machakos in the lower slopes of the Mua Hills. Although acreage statistics are inadequate, the crop also is grown on Vertisols in the district of Embu.

Chickpea is grown as a cash crop, sometimes twice in one year from the same area. The small brown-seeded desi type predominates; the area under white grain types is relatively small. Although growth was excellent in some fields, in others there was heavy mortality due to *Fusarium* wilt, dry root rot, and other causes. Wilt and root rots are aggravated by continuous cropping with chickpea in the absence of an alternative. One field where six consecutive crops of chickpea had been grown over a period of three years resembled a wilt-sick plot. The only other disease recorded was stunt at low incidence at the National Dryland Farming Research Station at Katumani.

Thus Kenya, which does not appear in FAO Production Yearbook Statistics, appears to have a much greater area of chickpea than has previously been recorded. The crop loss caused by wilts and root rots suggests that production could be substantially increased by incorporating resistance to these diseases into adapted backgrounds.

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Fertilizer Response of Chickpeas in India: An Analytical Review

The response of chickpeas to applied nitrogen (N) and phosphorus (P_2O_5) was examined by