U Res. J. 1996. 22 (1) : 35-39

Changes in Composition of the Seed in Bajra During Seed Development

J. J. Dhruve and M. Parameswaran

Department of Bio-Chemistry, College of Agriculture, Gujarat Agricultural University, Junagadh-362 001

ABSTRACT

Bajra seeds were harvested at 15, 18, 21, 24 and 27 days after full stigmatic stage (DAFSS) and also at 33 DAFSS at normal maturity. Mean dry seed weight and the content of protein, total carbohydrates, total soluble sugars and reducing sugars increased throughout seed development parallel to the decline in moisture per cent. DNA and RNA in the seed increased upto 24 DAFSS and then declined. At 24 DAFSS the seed had 97 per cent of dry weight, 89 per cent of protein and 88 per cent of total carbohydrate. The seeds harvested at this stage was already in the desiccation phase and had cent per cent germination.

(Received on 16th Janu., 1995)

INTRODUCTION

The bajra crop is normally harvested at 90-100 days after sowing which roughly corresponds to 30-35 days after full stigmatic stage (anthesis) in most of the earheads in 50 per cent of the plants in the field. Harvesting the crop earlier may be advantageous to the breeder for germplasm collections. Harvesting early might also help to prevent loss due to bacterial and fungal diseases and bird damage which are common in bajra. In the present experiment we harvested bajra seeds at different intervals during seed development to see how early the seeds can be harvested so that the seed has good germination and at the same time, it has accumulated more than 90 per cent of all reserve materials. Results clearly showed that early harvest is possible without much loss of seed components.

MATERIALS AND METHODS

Bajra variety GHB-30 was grown during *kharif* 1990 under normal cultural practices in the Agronomy Farm, Gujarat Agricultural University, Junagadh.

The earheads were tagged at full stigmatic stage (FSS) and harvested at 15, 18, 21, 24 and 27 days after full stigmatic stage (DAFSS). The earheads were also collected at 33 DAFSS. The harvested earheads were air dried for 5-6 days and then seeds in the one third of middle portion of the earheads were collected, cleaned of extraneous matter and used for compositional analysis.

The seeds were dried at 110° C for 5 hours and the loss of weight was expressed as moisture content. The nucleic acids were

extracted by the method of Smillie and Krotkov (1960), and DNA was estimated by the diphenylmine reaction (Abraham *et al.*, 1972), while RNA was estimated by the orcinol reaction. (Volkin and Cohn, 1954). Total nitrogen was estimated by the microkjeldahl method (A.O.A.C. 1965) and crude protein content was calculated (N x 6.25). From an alcoholic extract of the tissue free amino acids were estimated by ninhydrin method (Lee and Takahashi 1966). Total carbohydrate content was estimated following the acid hydrolysis method (Dreywood (1946) and Bruyn *et al.*, (1968)). The total soluble sugars were estimated by phenol sulphuric acid method (Dubois *et al.*, 1951), while reducing sugars were estimated using the arsenomolybdate reagent (Nelson, 1944). The non-reducing sugar content was calculated by the difference between total soluble sugars and reducing sugars.

RESULTS AND DISCUSSION

The mean dry seed weight increased throughout the seed development period as the per cent moisture declined (Fig. 1a). The water content of the seed increased during 15 to 18 DAFSS and then declined continously (Fig. 1a). This period i.e., 15 to 18 DAFSS witnessed higher rates of RNA accumulation in the seeds. The DNA content per seed increrased during 15 to 18 as well as 18 to 21 DAFSS indicating that the DNA synthesis continued longer than the active RNA synthesis (Fig. 1B). Since active cell division must be taking place either before or concurrent with RNA synthesis these data suggest that the bajra seed makes more DNA than needed for cell division. A similar trend was observed in wheat (Kapoor and Heiner, 1976), sorghum (Johari *et al.* 1977) and in bajra (Tulsidharan, 1985). Tulsidharan (1985) has also reported that the peak of RNA levels occurred earlier than that of DNA in bajra which supports the present experimental results.

The protein content of the seed increased continuously, although the rate of accumulation was maximum during 18 to 21 DAFSS i.e., immediately following maximum RNA accumulation (Fig. 1c). In maize (Ingle *et al.* 1965) sorghum (Johari *et al.*, 1977), bajra (Tulsidharan, 1985) and in rice (Li and Okita, 1993), protein content increased throughout seed development period. Sahee and Das (1991) have also observed same trend in four varieties of rice.

The content of amino acids increased gradually from 15 to 24 DAFSS followed by a decline, which suggest that these amino acids were utilized in protein systhesis. Similar trend was observed in maize endosperm (Ingle *et al.*, 1965).

The carbohydrate compositional changes (Fig. 1d) showed that total carbohydrates, total soluble sugars (including reducing and non reducing) increased throughout seed development, 90% of which had accumulated by 24 DAFSS. But maximum changes occurred during 15 to 18 DAFSS for total carbohydrates which coincided with maximum increases in water and RNA content. Maximum increases for soluble sugars occurring during 21-24 DAFSS coincided with the maximum increases in free amino acids. The occurrence of higher rate of sugar and free amino acids after the higher rate of accumulation of total carbohydrates and proteins in the developing seed, may be due to a

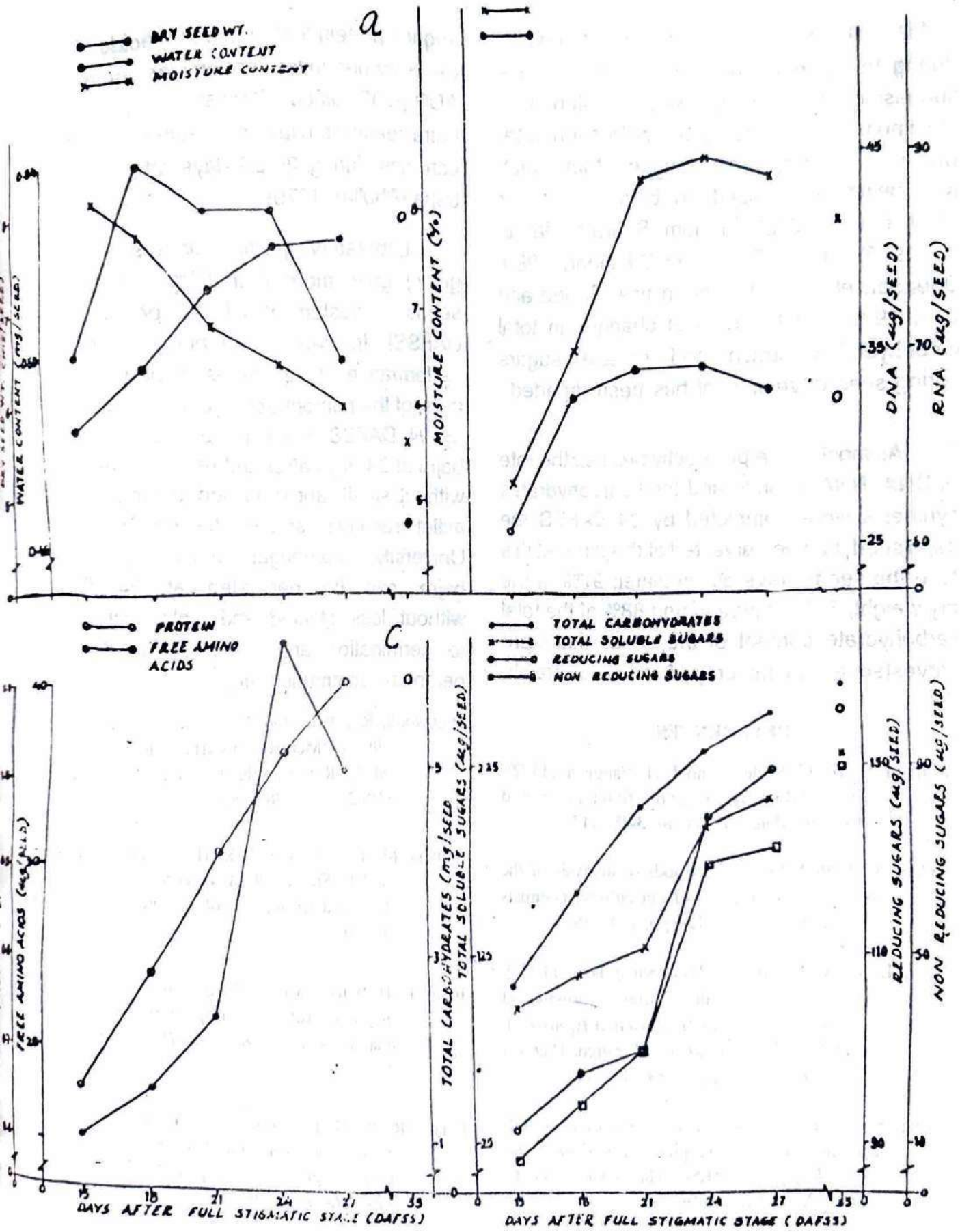


Fig. 1 : Compositional changes during seed development in bajra.

sudden fall in the synthesis of macro molecules during this period. Ingle *et al.*, (1965) have suggested that in maize sugar content was maximum at 20 days after pollination after which it decline, which suggest that starch was being synthesized. In bajra and jowar (Bhatia *et al.*, 1972) sorghum (Subramanian *et al.*, 1983) wheat (Tahir and Sikandar, 1989; Obendorf *et al.*, 1993) and in rice (Sahee and Das, 1991), similar trend of changes in total carbohydrates strach and soluble sugars during seed development has been reported.

As most of the peak activities i.e., the rate of DNA, RNA, protein and total carbohydrates synthesis were completed by 24 DAFSS the bajra seed may be harvested at this time. At this time the seeds have accumulated 97% of the dry weight, 89% of protein and 88% of the total carbohydrate content of the seeds that were harvested at full maturity. A study of starch, sugars, protein and free amino acids along with the enzymes invertase, amylase and sucrose ADP (UDP) glucosyl transferase in developing bajra seeds also gave plateauing of content and activities during 20-25 days after anthesis in bajra (Bhullar, 1979).

Laboratory germination tests (data not given) gave more than 95% germination in seeds harvested at all the periods (15-27 DAFSS). In view of the normal germination performance at all harvest schedule and as most of the nutrient accumulation is completed by 24 DAFSS it will be possible to harvest bajra at 24 days after anthesis for use as seed without significant reduction in yield. Work at millet research station, Gujarat Agricultural University, Jamnagar have indicated that bajra can be harvested at 24 DAFSS without loss of yield and quality with respect to germination and storability (A. K. Joshi, personal communication).

REFERENCES

Abraham, G. H.; C. Scaletta and J. H. Vaughan. (1972). Modified diphenyl amine reaction for increased sensitivity. *Anal. Bio-chem.* **349** : 547-551.

A. O. A. C. (1965). Official methods of analysis of the association of official of agricultural chemists 1oth Ed. Washington Dc. pp. 744-745.

Bhatia, I. S.; R. Singh and Mrs. Saroj Dua. (1972). Changes in carbohydrates during growth and development of bajra (*Pennisetum typhoides*), jowar (*Sorghum vulgare*) and kangni (*Setaria italica*). *J. Sci. Fd. Agric.* **23** : 429-440.

Bhullar, S. S. (1979). Bio-chemical control of starch accumulation in developing bajra (*Pennisetum typhoides*) grains. M.Sc. Thesis submitted to Punjab Agril. University.

Bruyn, D. J. W., H. A. Vankeulen and J. H. A. Ferguson, (1968). Rapid method for the simultaneous determination of Glucose and Fructose using Anthrone reagent *J. Sci. Fd. Agric.* **19** : 597-601.

Dreywood, R. (1946). Ind. Eng. Chem. Anal, Ed. 18 : 499 cf. 'Methods in carbohydrate chemistry' ed. by Roy, L. Whisther and M. L. Wolfrom (1962) vol. 1: 389-390.

Dubois, M.; K. A. Gillies; J. K. Hamilton; F. A. Reber and F. Smith (1951). A colorimetric method for the determination of sugars. *Nature* **168** : 167-168.

Ingle, J.; D. Beitz and R. H. Hageman (1965). Changes in composition during development and maturation of maize seeds. *Plant Physiol.* **40** : 835-839.

Johari, R. P.; S. L. Mehta and M. S. Naik (1977). Protein synthesis and changes in nucleic acids during grain development of sorghum. *Phytochem.* **16** : 19-24.

Kapoor, A. C.; and R. E. Heiner. (1976). Bio-chemical changes in developing wheat grain. I. changes in protein, carbohydrate and nucleic acid. *Can. J. Plant Sci.*. **56** : 385-391.

Lee, Y. P. and T. Takahashi, (1966). An improved colorimetric determination of amino acids with the use of ninhydrin. *Anal. Bio-chem.* **47** : 71.

Li, X. X.; T. W. Okita, (1993). Accumulation of prolamines and glutelins during rice seed development; A quantitative evaluation. *Plant and cell physiology.* **34** : 385-390.

Nelson, N. (1944). A Photometric adaptation of the Somogi method for the determination of glucose. *J. Biol. Chem.* **153** : 375-380.

Obendorf, R. L., M. Horbowicz; D. P. Taylor (1993). Structure and chemical composition of developing buckwheat seed. In new crops. New York USA, John Willey and Sons, Inc. pp; 244- 251.

Sahee B. C. and A. K. Das (1991). Bio-chemical changes during maturation and development of rice grain (*Oryza sativa*). *Madras Agric. J.* **78** (58) : 168-170.

Smillie, R. M.; and G. Krotkov, (1960). The estimation of nucleic acids in some algae and higher plants. *Can. J. Bor.*, **38** : 31-49.

Subramanian, V.; R. Jambunathan and N. Seetharama, (1988). Bio-chemical changes during seed development in sorghum (Sorghum bicolor). *Phytochem.* **22** : 1097-1101.

Tahir, I. and F. Sikandar, (1989). Accumulation of nitrogen and carbohydrate reserves in grains of four buckwheat (Fagopyrum Spp.) during development. *Plant physiol. Bio-chem.* **16** : 57-61.

Tulsidharan, (1985). Physiological and Bio-chemical changes during seed development and germination. Ph.D. Thesis. S. P. University, Vidyanagar (Gujarat).

Volkin, E. and W. E. Cohn, (1954). In methods of Bio-chemical analysis. Vol. 1, pp. 287.