Summary
Varietal difference of hybrid bajra, in terms of growth, development and yield mediated through physio-biochemical parameters were studied. Three hybrid varieties of bajra, BK 560-230, BJ 104 and CJ 104 were selected for the study. Experiments were conducted on seedlings raised in the laboratory and on field-grown plants. 20 ppm gibberellic acid (GA$_3$) was supplied to understand the response of exogenous GA$_3$ on different genetic lines. To the laboratory raised seedlings, GA$_3$ was added to the substrate and in the field grown plants GA$_3$ was given as foliar spray. Following is an excerpt of the observations.
The three genetic lines showed different trends in the various growth and biochemical parameters. A differential response to the exogenous \( \text{GA}_3 \), in terms of overall effect as well as at specific growth periods were observed in the three genetic lines. During seed germination and seedling growth, the radicle elongation was higher in CJ 104 followed by BJ 104 and BK 560-230. There was an inverse relation between elongation and dry matter yield of radicle. \( \text{GA}_3 \) reduced the elongation and dry matter yield of radicle in all varieties. \( \text{GA}_3 \) enhanced the elongation of leaf in all varieties, but the dry matter yield increased only in BK 560-230, and in the other two varieties the dry matter yield decreased. Among the controls, the leaves of BJ 104 achieved a higher dry matter yield.

In the endosperm of all varieties, during germination and seedling growth, the highest level of reducing sugar, total sugar and the activity of enzymes, amylases, peroxidases, phenylalanine ammonia lyase and nitrate reductase were observed at 24 h after imbibition which gradually decreased as the growth period advanced. The protein mobilisation occurred at a later period compared to the starch hydrolysis. The mobilisation of starch was more efficient in BJ 104 followed by CJ 104 and BK 560-230. The maximum level of protease activity was observed at 96 h. The ribonuclease activity fluctuated during the seedling development. The maximum
catalase activity was observed at 48 h. The phenylalanine ammonia lyase activity reduced when the tyrosine ammonia lyase activity increased. The mobilisation of protein was more efficient in CJ 104 followed by BJ 104 and BK 560-230.

The overall effect of $GA_3$ for the 6 periods showed that, in BJ 104 and CJ 104, $GA_3$ enhanced the reducing and total sugar content, while retarded in BK 560-230. Invertase activity slightly enhanced in CJ 104, while retarded in BJ 104 and BK 560-230. Initially, $GA_3$ retarded the starch and protein degradation, however from 48 h $GA_3$ enhanced the rate of starch and protein degradation. $GA_3$ enhanced the $\alpha$-amylase and ribonuclease activity in all the varieties. In CJ 104, $GA_3$ retarded the $\beta$-amylase and promoted in BJ 104 and BK 560-230. $GA_3$ enhanced phenylalanine ammonia lyase in BK 560-230 and in CJ 104, while retarded in BJ 104. $GA_3$ retarded the tyrosine ammonia lyase and catalase activity in all the varieties.

In the leaves of the control seedlings, the total starch hydrolytic activity, phenylalanine ammonia lyase activity, tyrosine ammonia lyase activity, protein and the reducing sugar content were more in CJ 104 followed by BJ 104 and BK 560-230. The total soluble sugar content was more in BJ 104 followed by CJ 104 and BK 560-230. The invertase, catalase and starch content were more in BK 560-230 followed
by BJ 104 and CJ 104. α-amylase activity was higher in CJ 104 followed by BK 560-230 and BJ 104. The protease and ribonuclease activity were higher in BJ 104 followed by CJ 104 and BK 560-230. The chlorophyll content was higher in BK 560-230 followed by BJ 104 and CJ 104. 40 mM potassium nitrate was the optimum concentration for nitrate reductase activity.

In the leaves of the seedlings of all varieties, GA$_3$ reduced the starch, chlorophyll and protein contents and the activity of amylases, protease, ribonuclease, catalase and nitrate reductase. GA$_3$ enhanced the reducing sugar content and total nitrogen content in BJ 104 and CJ 104, while reduced in BK 560-230. GA$_3$ promoted invertase and phenylalanine ammonia lyase activity in all the varieties. GA$_3$ enhanced tyrosine ammonia lyase activity in BK 560-230 and in CJ 104, while reduced in BJ 104. In terms of seedling growth mediated by various biochemical parameters mentioned above, the performance of BJ 104 was better compared to BK 560-230 and CJ 104.

In the field grown plants, the foliar spray with GA$_3$ modified the growth and biochemical activities differentially in the three genetic lines. The plant height was higher in BK 560-230 followed by BJ 104 and CJ 104. In BK 560-230 and in BJ 104, GA$_3$ enhanced the plant height...
only up to the flag leaf stage. In C3 104, GA\textsubscript{3} treatment enhanced the plant height throughout the growth period. A higher dry matter yield was observed in BJ 104 till flag leaf stage. Thereafter, due to the production of more number of tillers in BJ 104, the increase in dry matter yield became low compared to BK 560-230. In BK 560-230 and in BJ 104, GA\textsubscript{3} reduced the total dry matter yield due to the low photosynthetic carbon dioxide assimilation. The total and effective tillers were more in C3 104 followed by BJ 104 and BK 560-230. GA\textsubscript{3} enhanced the number of effective tillers in all the varieties, but the number of total tillers reduced in BJ 104. The ear length, grain weight per ear and the 1000 grain weight were more in BK 560-230 followed by BJ 104 and C3 104. GA\textsubscript{3} increased the ear length and grain weight per ear in C3 104 and reduced in BK 560-230 and in BJ 104. GA\textsubscript{3} enhanced 1000 grain weight in BK 560-230 and reduced in the other two varieties.

In the lower leaves and the flag leaves, the hydrolases like invertase and amylases showed a higher activity at the soft dough stage and thereafter started declining. The concentration of total sugar, reducing sugar, starch and protein content were parallel to the chlorophyll content. In the lower leaves and the flag leaves, a higher protein content was associated with low protease activity and vice versa. The maximum level of chlorophyll content and metabolic
activities were observed at the anthesis and soft dough stage. \(\text{GA}_3\) reduced the chlorophyll content and the overall metabolic activities till anthesis. However, \(\text{GA}_5\) delayed the senescence by retaining the leaves with a high level of chlorophyll content and high rate of metabolism.

In the developing grains, the maximum number of sugars were observed at the soft dough stage and amino acids at the hard dough stage. The total sugar and reducing sugar contents increased up to 18 days after anthesis and then slightly declined. In the mature dried grains of the three varieties, the total sugar content is higher in BJ 104 followed by BK 560-230 and CJ 104. \(\text{GA}_3\) enhanced the total and reducing sugar content in all the varieties. The starch, protein and total nitrogen increased till harvest. \(\text{GA}_3\) enhanced the starch content in BK 560-230 and reduced in BJ 104 and CJ 104. The protein content was higher in CJ 104 followed by BK 560-230 and BJ 104. \(\text{GA}_3\) enhanced the protein and total nitrogen in all the varieties.