Table 1 *Yield of oil from oilseeds using microbial enzymes in the presence of hexane*

	% yield of oil from seeds*											
	Cotton			Sunflower			Soybean			Castor		
Enzyme conc. (per cent)	1	2	3	1	2	3	1	2	3	1	2	3
Enzyme source												
A. fumigatus	16.76	18 10	19.39	33.96	35.46	36 86	21.92	23.23	24.22	46 23	47 37	48.76
S. thermophile	16.96	18.31	19.16	34.00	35.21	36.22	21.78	22.92	24.11	46.21	47.72	48.93
H. lanuginosa-I	17.21	18.32	19.51	34.23	35.62	36.64	21.35	22.49	23.69	46.96	48.21	49.26
H. lanuginosa-II	16.31	17.52	18.96	34.31	35.32	36.54	21.23	22.52	23.50	47.10	48.32	49 06
Cellulase**	16.42	17.77	18.82	33.96	34.31	35 86	21.69	22.36	23.32	46.21	47.31	48.61
Hemicellulase**	16.10	17.72	18.77	33.49	34.52	35.75	21.47	22.35	23.12	46.36	47.52	48.42

*Yield of oil from seeds in control (%): cotton, 15.20; sunflower, 32.65; soybean, 20 33; castor, 45.50.
**Sigma Chemical Co., USA.

filtration through Whatman No. 1 paper and used as crude enzyme preparation. Cellulase and hemicellulase, purchased from Sigma Chemical Co., USA, were used in some experiments.

For oil extraction in the presence of crude/ purified enzymes, 1–3% levels were employed. Suitable aliquots of enzyme were added to the weighed and crushed oilseeds (10 g each) in 250 ml flasks. The reaction was carried out at 45 ± 2°C for 8 hr in the presence/absence of hexane. Oil was extracted in each case and yield calculated on per cent basis with comparison to controls that were run without addition of enzyme to the seeds.

From the data based on duplicate set of experiments it has been adduced that oil yield increased in most cases (table 1). The recovery of oil from cotton increased by 2–5% when an enzyme preparation from *H. lanuginosa* I was employed. Addition of crude enzyme from *A. fumigatus* improved oil recovery by 4·2% in sunflower; this preparation was also effective in better oil yield from soybean. Oil yield from castor was improved by an enzyme preparation from *H. lanuginosa* I. Commercially available preparations of cellulase and hemicellulase were slightly inferior to enzyme preparations from any of the four thermophilous moulds. Oil yield was greater in the presence of hexane than in samples without this solvent.

It would appear that solvent extraction of oil in the presence of enzyme(s) allows greater solubilization of plant tissue and proteins to which oil may remain bound even after the normal extraction procedures. Further studies on improved oil recovery and their fatty acid make up are currently underway. In view of the shortage of oilseeds, any improved technology with greater oil yield will be a welcome sign. This is a novel field of microbial biotechnological research which holds potential for commercial exploitation.

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NEW APPROACHES TO REDUCE THE COST OF HYBRID SEED PRODUCTION: I USE OF HORMONES

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HYBRID cotton has revolutionized cotton cultivation in our country and is a crucial factor in the

attainment of self-sufficiency. The major constraint in the rapid spread of hybrid cultivation is the prohibitive cost of the seed. Since commercial hybrid seed production is a labour-intensive endeavour because of hand emasculation and pollination, the seed produced will be invariably priced high. Low percentage of crossed bolls in some of the leading commercial hybrids was reported[1-3] in H4 and Varalaxmi and appear to be a major constraint, further escalating the cost factor.

The release of ethylene as a result of emasculation of flower bud due to wound injury was reported earlier[4]. Ethylene, being a senescence-promoting hormone[5], might induce subtle changes in the female flower after emasculation leading to poor setting and enhanced shedding. Improved setting percentages up to 60% were reported with the use of male sterile lines[6] due to the elimination emasculation. Hormonal derangement (either ethylene-mediated or otherwise) appear to be a causal factor leading to lowered setting percentages in crossed bolls in some of the combinations. An attempt has been made in the present study to evaluate the efficacy of spot application of gibberillic acid (GA_3), in overcoming the emasculation injury for realising higher setting percentage. So far no attempt has been made in this direction in our country in commercial hybrid seed production.

In the H-4 hybrid seed production programme an experiment was laid out with the following GA_3 treatments: T_1 : GA_3 (50 ppm) throughout the crossing period (56 days); T_2 : GA_3 (50 ppm) for 30 days from the commencement of crossing season followed by complete removal of newly formed reproductive forms at regular intervals; T_3 : GA_3 (100 ppm) as in T_1; T_4: GA_3 (100 ppm) as in T_2; T_5: Control-crossing period of 56 days (normal practice).

Hormonal treatments were superimposed by giving a light touch with cotton buds dipped in GA_3 solution of the above mentioned concentrations at the base of the gynoecium portion immediately after emasculating the flower. Care should be taken not to apply excess quantity of GA_3 solution by way of repeated touches and prolonged time of application. From a total of 550 plants, 40 plants were selected randomly and treatments were tested with four replications and observations on setting percentage, seed yield per plant, seed weight per boll, seed number per boll and seed indices and germination percentages over stratified harvests were recorded and are presented in tables 1 and 2.

Table 1 *Effect of GA_3 on setting percentage, seed yield and seed attributes in hybrid (H4) seed production*

Treatment	% Boll setting	Seed yield/ plant	Seed weight/ boll (g)	Seed number/ boll
T_1	55.0	142.2 (40.93)	1.91	17.1
T_2	58.4	168.9 (66.3)	2.24	18.9
T_3	56.3	91.6 (−9.2)	1.54	13.9
T_4	64.9	129.5 (28.34)	1.89	15.8
T_5	32.7	100.9	2.11	17.7
CD 5%	6.4	18.8	0.31	1.9

Values in parentheses indicate per cent increase or decrease over control (T_5).

Table 2 *Effect of GA_3 on seed index and germination percentage over stratified harvests in hybrid (H4) seed production*

Treatment	Seed index (g) pickings					Germination percentage pickings				
	I	II	III	IV	V	I	II	III	IV	V
T_1	11.1	10.5	10.0	9.5	9.4	73.5	75.5	62.0	53.0	45.0
T_2	11.4	11.1	10.2	9.9	9.7	74.0	77.5	65.0	56.5	49.0
T_3	10.6	10.0	9.8	9.0	8.9	73.0	75.0	61.5	52.5	43.0
T_4	11.0	10.5	10.1	9.6	9.4	72.5	75.5	63.5	53.5	46.5
T_5	11.1	11.3	10.3	9.7	9.4	73.0	77.0	61.5	53.0	45.5
CD 5%	0.3	0.3	0.2	0.2	0.2	NS	NS	1.2	0.9	2.2

GA_3 treatments in general increased the setting percentage significantly over control, the maximum value getting expressed with 100 ppm GA_3 T_4 treatment with 98.5% increase over control. In view of the limited period of crossing (30 days) as compared to 56 days in control, this observation assumes considerable significance and clearly indicates the crucial role played by GA_3 in improving the setting percentage, GA_3 at 50 ppm (T_1 and T_2) and at 100 ppm (T_3) differed little amongst themselves. GA_3 at 50 ppm (T_2) gave significantly superior seed yield per plant without any impact on seed number and weight per boll. However, GA_3 at 100 ppm (T_3 and T_4) in spite of improved setting

percentage had brought about significant reduction in seed weight and seed number per boll, resulting in reduced seed yield per plant as compared with 50 ppm. In T_1, T_3 and T_4 treatments seed index values over stratified harvests showed significant reduction over control in some of the pickings while in T_2 treatment they were almost at par with control.

Germination percentages were at par in all the treatments excepting T_2 where the values were significantly superior to control in the later pickings.

GA_3 treatments for a limited crossing period proved to be superior to the ones extended over the entire period in terms of seed yield and quality attributes. Apparently, limiting the boll load on the plant seems to have an additive effect in improving the setting percentage. Beneficial effects of partial defruiting in increasing the retention of younger fruits due to the lowering of ethylene and abscisic acid levels in the plant system were reported[7,8] in cotton.

Gibberillic acid thus seems to bring about normalization of receptor base (gynoecium with stylar and stigmatic portions) in terms of growth, conditioning and hormonal balance between emasculation and pollination as also during the earlier stages of fruit development thus enabling much higher setting percentage inspite of emasculation injury and the resultant traumatic changes in terms of deranged hormonal balance (higher levels of ethylene) and subsequent metabolic manifestations. Thus GA_3 appears to be a potential tool to improve setting percentages and to realise much higher seed yield within approximately half the normal crossing period and with minimum impact on seed quality traits.

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EFFICIENCY OF S_1 METHOD FOR POPULATION IMPROVEMENT IN PEARL MILLET

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In order to isolate superior inbred lines, superior base population is a prerequisite. Various methods of population improvement have been proposed from time to time. Pearl millet is a cross-pollinated crop with high heterozygosity prevailing in the natural population. Therefore, a method which exposes greater variability and genetic advance would be more effective in providing material for selection of good genotypes. The present study is aimed at comparing the three methods i.e., S_1, half sib and full sib selections for their effectiveness in increasing the grain yield and its related traits.

The material consisted of 84 randomly selected plants from an isolation plot of composit JOB–GT–1. Each plant was selfed, allowed to be open-pollinated and crossed with a plant taken at random from the 84 plants. Thus from each plant three types of progenies were developed. They are: selfed (also known as S_1 progenies), half sib and full sib corresponding to the selfing, open pollination and crossing to the known selected plant respectively. All these three types of progenies were evaluated in three parallel experiments laid out side by side in R.B.D. with two replications. Each progeny was sown in a plot of 3 m × 0.8 m size consisting of two rows of 3 m length and spaced 40 cm apart. The plant-to-plant distance was adjusted to 15 cm by thinning at 3 to 4 leaf stage. At maturity, data were recorded on various morphological traits and analysed using standard statistical procedures to estimate genotypic and phenotypic coefficients of variation in each type of progeny.

Comparison on the basis of coefficient of variation (both genotypic and phenotypic) indicated that the coefficient of variation did not differ between different types of progenies for days to 50% flowering, plant height and ear length, thus all the three methods were uniform in expressing the variability with regard to these traits (table 1). The coefficient of variation was higher for tillers per plot, ears per plot and dry fodder weight per plot in S_1 than either in half sibs or full sibs. Thus it can be inferred that S_1 progeny method is more effective in