ORO-2976-23

MASTER

THREE-YEAR REVIEW

GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES.

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TO: The United States Atomic Energy Commission

FROM: University of Georgia, Georgia Coastal Plain Experiment Station, Tifton, Georgia

CONTRACT NO. AT-(40-1)-2976

REPORT NO. ORO-2976-23

REPORT PERIOD: May 1, 1968 to April 30, 1971

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GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES.

A Three-Year Review

INTRODUCTION

Research was begun in 1962 to study the effect of three cycles of recurrent seed treatment with various dosages of thermal neutrons (TN) and ethyl methane sulphonate (EMS) on general and specific combining ability for forage yield. Pearl millet, Pennisetum typhoides (Burm.) Stapf and C.E. Hubb., a diploid (2n = 14) annual grass used for forage in the United States, was chosen for this investigation because: (1) hybrids between certain inbreds exhibit much heterosis for forage yield, (2) studies involving many such hybrids revealed that the genetic variance for forage yield was about equally divided between general and specific combining effects, (3) chromosomal aberrations would not affect forage yields as they might be expected to affect grain yields, and (4) forage yields could be precisely measured (coefficients of variation <10%). Six well-established pearl millet inbreds were chosen for the investigation. Mutagen dosage efficiency was monitored by ascertaining the frequency of chlorophyll-deficient mutants resulting from each treatment. Only 'normal' plants, that looked like those from untreated seed, were selected for combining-ability studies. General and specific combining ability was estimated from the forage yields of 3 x 3 Design II (factorial design) crosses between two sets of three plants of the same treatment from each of two parent inbreds.

RESULTS AND DISCUSSION

<u>Evaluation of general and specific combining ability of selected plants having undergone three cycles of recurrent treatment</u>.

Each year for the past three years, we have measured the forage production of 486 singlecrosses by taking an original cutting at a pre-boot stage and two aftermath cuttings generally. These yields have been added together to give the total yields from which genetic variances have been calculated. In order to obtain the maximum precision in these yield measurements, we have used balanced 9 x 9 lattice square designs with five replications, designs that on the average have given a relative efficiency of about 200 percent. That is to say that these designs have given the same precision that we might have expected to get from randomized block experiments in which each entry was replicated ten times.

The 486 singlecrosses tested each year were the components of 54 3 x 3 diallels used to permit estimates of general and specific combining ability. The actual total yields obtained over the past three years are presented in Tables 1 through 18. The coefficient of variation for the experimental error for each of these 18 9 x 9 lattice square tests appear at the bottom of each table and range from 6.5 to 9.6 percent. All but two of these coefficients of variation fall below 9 percent, indicating that these yield tests over the past three years have

Table 1. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 1 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	11,724	11,870	11,788
	11,935	11,372	11,374
	11,769	11,561	10,906
	11,985	11,475	11,826
	11,436	10,674	11,339
	10,730	10,987	11,569
	11,536	11,082	11,727
	12,327	11,138	10,916
	10,575	11,185	11,930
Average	11,557	11,260	11,486
13 x 239	8,831	9,802	8,545
	8,963	9,970	9,135
	8,914	9,709	9,215
	8,439	9,468	9,039
	9,324	9,637	8,181
	8,503	9,467	9,204
	8,518	9,180	8,403
	9,372	9,467	8,440
	8,582	10,026	9,001
Average	8,827	9,636	8,796
239 x 23	11,434	11,440	11,956
	11,744	11,902	12,312
	12,011	11,559	11,668
	11,619	12,500	12,402
	11,561	11,467	11,178
	11,970	11,670	12,098
	12,334	11,947	12,153
	11,211	11,446	11,723
	11,722	11,315	11,291
Average	11,734	11,694	11,865
Grand Avg.	10,706	10,864	10,716

5% LSD for individual yields = 992; for averages of 9 yields = 331; for averages of 27 yields = 191.

CV = 7.4.

Table 2. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 2 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	13,048	13,345	13,126
	12,844	13,081	11,839
	11,898	13,129	12,354
	11,941	12,000	12,733
	9,893	12,924	12,639
	11,393	12,619	13,181
	12,365	13,956	12,889
	13,119	13,629	12,317
	12,831	12,647	12,869
Average	12,148	13,037	12,661
13 x 239	10,225	9,875	9,890
	9,921	10,032	9,672
	9,938	9,885	9,665
	10,794	10,784	9,852
	10,435	9,734	9,980
	10,145	9,464	10,481
	10,035	10,400	9,788
	10,321	10,476	10,162
	10,028	10,313	9,813
Average	10,208	10,107	9,923
239 x 23	13,070	12,932	12,685
	13,359	12,040	13,098
	12,544	12,600	12,743
	13,162	13,344	14,023
	12,995	12,723	13,301
	13,560	13,172	12,939
	13,198	13,061	13,264
	13,197	12,544	12,618
	12,498	12,932	12,728
Average	13,065	12,816	13,044
Grand Avg.	11,807	11,987	11,876

5% LSD for individual yields = 1,046; for averages of 9 yields = 349; for averages of 27 yields = 201.

CV = 7.1.

Table 3. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 3 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	11,644	11,226	11,472
	10,727	11,272	12,179
	12,930	10,804	10,933
	11,850	11,002	10,654
	11,113	11,516	11,616
	11,905	11,947	11,483
	11,877	10,878	11,732
	11,075	10,686	11,395
	11,475	10,863	12,476
Average	11,622	11,133	11,549
13 x 239	8,953	8,563	8,606
	8,044	8,784	8,865
	9,070	9,089	9,038
	9,102	8,892	8,596
	9,293	8,361	8,968
	9,269	8,717	8,726
	8,663	7,927	8,904
	9,260	8,793	8,831
	9,143	8,812	9,076
Average	8,977	8,660	8,456
239 x 23	10,893	11,148	11,505
	11,415	12,029	11,457
	10,618	11,322	12,107
	11,551	11,841	11,754
	11,579	12,205	12,109
	12,762	11,883	11,168
	11,735	12,074	12,539
	12,078	10,620	11,016
	11,245	11,362	11,429
Average	11,542	11,609	11,676
Grand Avg.	10,714	10,467	10,690

5% LSD for individual yields = 1,085; for averages of 9 yields = 362; for averages of 27 yields = 209.

CV = 8.2.

Table 4. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 4 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	11,828	11,793	12,309
	11,590	11,656	11,964
	12,118	11,429	11,845
	12,638	11,920	12,067
	11,934	12,978	12,052
	12,629	12,545	11,581
	11,809	11,885	11,692
	11,687	11,243	11,621
	11,974	10,921	12,620
Average	12,023	11,819	11,972
13 x 239	10,323	9,406	9,381
	9,314	9,668	8,858
	9,436	8,859	9,607
	8,741	9,505	9,560
	8,977	8,965	9,464
	8,958	8,305	9,198
	9,598	9,392	9,707
	9,465	9,136	8,430
	9,891	10,024	8,720
Average	9,411	9,251	9,214
239 x 23	12,278	11,779	12,468
	12,321	11,779	11,906
	11,774	11,677	12,192
	12,248	11,938	12,276
	12,218	11,850	12,336
	12,396	11,842	11,792
	12,018	11,267	12,107
	12,697	11,443	11,817
	12,029	11,076	12,045
Average	12,220	11,628	12,104
Grand Avg.	11,218	10,899	11,097

5% LSD for individual yields = 1,158; for averages of 9 yields = 386; for averages of 27 yields = 223.

CV = 8.4.

Table 5. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 5 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	12,418	12,552	12,545
	11,934	12,289	13,357
	12,852	11,869	11,942
	12,202	12,092	12,243
	12,451	12,720	12,507
	12,737	12,613	12,672
	12,052	11,656	12,116
	12,071	12,027	12,400
	12,195	11,879	12,535
Average	12,324	12,189	12,480
13 x 239	8,993	10,053	9,505
	9,871	10,577	10,131
	9,310	10,532	9,404
	8,624	9,136	9,305
	9,715	9,426	10,610
	9,566	9,029	9,311
	8,949	9,162	9,555
	9,372	9,090	8,946
	9,658	9,484	8,851
Average	9,340	9,610	9,513
239 x 23	12,608	11,373	12,160
	12,932	12,673	12,092
	12,512	12,248	12,290
	12,107	12,562	12,654
	12,259	11,969	11,935
	12,386	12,057	11,613
	12,629	12,572	13,242
	13,077	11,640	12,803
	12,755	12,395	12,064
Average	12,585	12,165	12,317
Grand Avg.	11,416	11,322	11,437

5% LSD for individual yields = 1,121; for averages of 9 yields = 374; for averages of 27 yields = 216.

CV = 8.0.

Table 6. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 6 grown at Tifton, Georgia in 1968.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	12,962	13,393	12,525
	12,738	11,962	13,340
	13,729	11,898	12,573
	14,298	12,156	13,178
	13,003	12,174	13,537
	13,746	13,126	12,943
	13,361	13,053	13,068
	13,714	13,315	13,592
	12,786	13,196	13,241
Average	13,371	12,697	13,111
13 x 239	8,715	8,891	8,991
	7,945	8,359	8,546
	8,616	8,002	8,369
	9,529	10,163	8,772
	8,970	10,536	8,655
	8,774	9,243	9,235
	8,892	8,750	8,706
	7,134	8,966	9,261
	8,997	8,798	8,152
Average	8,619	9,079	8,743
239 x 23	13,049	12,741	13,244
	12,837	13,354	12,917
	12,820	13,184	13,671
	13,164	12,213	13,363
	12,629	12,359	12,962
	13,229	13,183	13,337
	14,880	13,736	13,355
	13,971	12,402	12,246
	13,196	12,539	13,283
Average	13,308	12,857	13,153
Grand Avg.	11,766	11,544	11,669

5% LSD for individual yields = 1,138; for averages of 9 yields = 379; for averages of 27 yields = 219.

CV = 7.9.

Table 7. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 1 grown at Tifton, Georgia, in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,769	9,752	9,580
	9,984	9,655	9,259
	9,809	9,340	9,552
	9,184	9,458	9,640
	9,337	9,606	9,289
	9,351	9,115	9,192
	9,693	9,938	9,194
	9,782	9,686	9,442
	9,494	10,009	9,095
Average	9,600	9,618	9,360
13 x 18	9,910	10,409	9,712
	9,750	10,515	10,347
	10,202	9,699	10,249
	10,092	10,101	10,309
	10,365	9,954	10,168
	9,818	10,665	10,482
	9,086	10,202	10,621
	9,695	10,399	10,074
	9,594	9,567	10,813
Average	9,835	10,168	10,308
18 x 23	9,060	*4,624	9,900
	9,333	10,009	9,730
	9,137	9,484	9,364
	9,261	9,457	9,298
	9,262	9,912	9,703
	9,227	9,142	9,298
	8,976	9,311	9,247
	9,026	9,553	9,747
	8,911	9,711	9,660
Average	9,133	9,572	9,550
Grand average	9,523	9,786	9,739

*Selfed inbred 18 rather than hybrid, probably the result of making the cross with pollen that was too old.

5% LSD for individual yields = 646; for averages of 9 yields = 215, for averages of 27 yields = 124. C.V. = 7.20.

Table 8. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 2 grown at Tifton, Georgia in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	10,196	10,171	9,694
	10,240	9,960	9,818
	9,344	10,167	10,297
	7,900	10,740	9,999
	8,100	9,864	10,113
	8,815	10,356	9,096
	9,948	11,052	9,953
	10,800	10,415	9,505
	9,407	10,355	9,654
Average	9,417	10,342	9,792
13 x 18	10,521	11,187	11,002
	10,625	10,797	10,253
	10,218	10,416	11,087
	10,948	10,128	11,155
	10,648	10,562	10,784
	9,834	10,321	10,511
	10,803	11,259	10,507
	10,958	10,040	10,323
	10,223	10,007	10,568
Average	9,450	10,524	10,688
18 x 23	10,176	10,286	9,997
	10,398	10,734	9,864
	10,770	10,192	9,975
	10,673	10,037	9,681
	9,977	10,678	10,229
	10,145	9,687	10,138
	10,125	10,280	10,731
	10,216	10,633	10,597
	10,151	10,856	9,794
Average	10,292	10,376	10,112
Grand average	9,720	10,414	10,197

5% LSD for individual yields = 699, for averages of 9 yields = 233, for averages of 27 yields = 135. C.V. = 7.32.

Table 9. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 3 grown at Tifton, Georgia in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,772	9,732	10,260
	9,298	9,769	8,954
	10,223	10,339	10,198
	9,630	9,521	9,812
	9,848	9,823	9,563
	10,021	9,992	9,355
	10,223	10,017	9,764
	9,618	9,194	10,453
	10,090	10,218	10,110
Average	9,858	9,845	9,830
13 x 18	9,733	10,337	10,374
	10,590	10,325	10,435
	10,282	10,167	10,561
	10,149	10,705	10,271
	10,514	10,743	10,568
	10,042	10,838	10,556
	10,449	10,586	9,953
	10,393	10,649	10,507
	10,892	10,813	10,497
Average	10,338	10,574	10,414
18 x 23	8,997	8,799	10,790
	8,810	9,953	10,506
	10,355	10,233	9,912
	10,433	9,710	10,683
	10,372	10,133	10,133
	11,108	9,193	9,948
	10,725	9,442	9,397
	9,828	9,771	10,443
	10,582	10,032	9,711
Average	10,134	9,696	10,169
Grand aver.	10,110	10,038	10,138

5% LSD for individual yields = 780, for average of 9 yields = 260, for average of 27 yields = 150. C.V. = 8.25.

Table 10. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 4 grown at Tifton, Georgia in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	10,485	10,420	9,765
	10,514	10,142	9,969
	10,219	10,280	10,313
	10,214	9,998	9,989
	10,253	10,693	9,470
	10,569	10,200	9,946
	9,982	10,746	9,800
	10,478	10,278	9,429
	10,096	10,293	10,690
Average	10,312	10,339	9,930
13 x 18	10,128	10,576	10,477
	10,858	10,861	10,793
	10,939	10,952	10,961
	10,277	10,467	10,879
	10,663	11,036	11,302
	10,467	10,402	10,342
	9,731	10,093	10,539
	9,651	10,535	11,111
	9,817	10,980	10,930
Average	10,281	10,656	10,815
18 x 23	10,001	9,897	10,282
	9,772	9,837	9,775
	11,607	11,236	10,017
	10,071	10,264	9,446
	10,419	10,375	10,354
	10,089	9,961	10,079
	10,757	9,709	10,236
	10,573	9,891	10,314
	11,430	10,007	10,483
Average	10,524	10,131	10,110
Grand aver.	10,372	10,375	10,285

5% LSD for individual yields = 658, for average of 9 yields = 219, for average of 27 yields = 127. C.V. = 6.81.

Table 11. Total dry matter yields (lbs. per A.) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 5 grown at Tifton, Georgia in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,698	9,176	10,324
	9,385	10,564	9,953
	8,804	10,216	10,408
	10,395	9,141	10,530
	9,598	9,538	9,777
	10,391	9,980	9,819
	10,238	9,695	9,743
	10,221	10,001	10,295
	9,775	9,958	9,720
Average	9,834	9,808	10,063
13 x 18	10,097	10,668	10,127
	10,559	10,694	10,412
	10,114	10,621	10,237
	10,878	10,798	10,848
	10,924	10,832	10,703
	10,365	10,248	10,142
	10,102	10,780	10,606
	10,288	10,990	10,248
	10,703	11,092	10,479
Average	10,448	10,747	10,422
18 x 23	9,625	9,496	11,555
	9,668	9,457	9,551
	10,773	9,842	10,061
	11,026	10,093	9,762
	10,096	9,882	10,574
	9,779	9,762	10,561
	10,538	9,745	9,779
	10,253	9,845	9,782
	10,208	9,977	9,604
Average	10,218	9,789	10,136
Grand aver.	10,167	10,115	10,207

5% LSD for individual yields = 618, for average of 9 yields = 206, for average of 27 yields = 119. C.V. = 6.51.

Table 12. Total dry matter yields (lbs. per acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 6 grown at Tifton, Georgia in 1969.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	10,713	9,913	9,994
	10,296	8,614	9,906
	9,275	9,197	10,142
	10,007	9,843	10,399
	9,380	9,301	10,055
	9,620	9,924	9,610
	10,161	10,327	9,711
	10,352	10,558	9,400
	9,055	9,651	9,942
Average	9,873	9,703	9,907
13 x 18	9,773	10,286	10,385
	10,107	10,440	9,955
	10,512	10,416	9,830
	10,011	10,662	10,729
	9,984	10,413	9,949
	9,954	9,869	10,141
	9,730	10,361	10,508
	10,288	10,342	10,676
	10,623	10,088	10,098
Average	10,109	10,320	10,252
18 x 23	9,827	9,961	9,917
	10,002	9,649	9,922
	10,140	9,530	10,063
	9,821	8,853	8,509
	9,808	9,140	9,671
	9,729	8,863	9,611
	9,330	9,409	9,669
	10,085	8,810	10,060
	10,013	9,242	9,888
Average	9,862	9,274	9,701
Grand aver.	9,948	9,766	9,953

5% LSD for individual yields = 698, for average of 9 yields = 233, for average of 27 yields = 134. C.V. = 7.56.

Table 13. Total of 3 dry matter yields (lb/acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 1 at Tifton, Georgia in 1970.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,344	8,882	8,606
	9 389	8,456	8,975
	8,666	9,167	8,727
	8,701	8,384	8,734
	8,767	8,713	8,818
	8,703	8,894	9,209
	9,303	9,265	8,833
	9,017	9,023	8,316
	8,434	8,904	8,935
Average	8,925	8,854	8,795
13 x 18	8,775	8,413	9,675
	8,911	9,335	8,672
	9,194	9,737	9,209
	8,822	9,171	9,462
	9,358	9,586	7,272
	8,767	9,653	8,520
	9,412	9,237	9,769
	10,128	9,535	8,116
	9,590	10,172	9,884
Average	9,217	9,427	8,953
18 x 23	9,060	9,140	9,178
	8,789	9,022	9,587
	9,693	8,499	9,077
	8,763	9,807	8,615
	9,038	9,351	9,067
	8,466	8,827	9,445
	9,182	9,447	9,143
	8,569	9,760	9,362
	9,180	8,800	8,633
Average	8,971	9,184	9,123
Grand Average	9,038	9,155	8,957

5% LSD for individual yields = 901; for average of 9 yields = 300; for average of 27 yields = 173. C.V. = 7.95

Table 14. Total of 3 dry matter yields (lb/acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 2 at Tifton, Georgia in 1970.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,374	8,557	8,508
	9,538	8,886	8,307
	9,612	8,505	8,938
	9,537	9,533	7,995
	8,551	8,517	7,865
	8,838	8,843	8,265
	8,946	8,732	8,875
	8,526	8,914	9,071
	8,911	8,743	8,326
Average	9,093	8,803	8,461
13 x 18	8,534	8,756	9,117
	9,321	9,119	9,878
	9,847	8,344	10,050
	9,529	9,151	9,715
	9,515	8,402	9,738
	9,583	10,323	8,861
	9,190	9,790	9,735
	9,564	9,439	10,205
	9,361	9,809	9,519
Average	9,383	9,237	9,646
18 x 23	9,405	8,839	9,032
	9,111	8,240	8,935
	9,593	9,591	9,524
	9,138	9,024	9,499
	10,362	7,904	9,373
	8,714	9,139	9,359
	10,379	9,231	9,642
	9,913	8,099	10,206
	9,234	10,439	9,582
Average	9,539	8,945	9,461
Grand Average	9,338	8,995	9,190

5% LSD for individual yields = 1,092; for averages of 9 yields = 364; for averages of 27 yields = 210. C.V. = 9.50

Table 15. Total of 3 dry matter yields (lb/acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 3 at Tifton, Georgia in 1970.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	8,820	9,105	9,181
	9,059	8,144	9,018
	8,045	8,843	8,821
	8,613	8,200	9,109
	8,689	8,853	8,207
	8,475	8,550	8,763
	9,222	8,764	9,173
	9,038	9,236	9,017
	8,360	8,581	9,105
Average	8,702	8,697	8,933
13 x 18	9,257	9,288	8,975
	9,162	9,617	8,964
	10,096	10,360	8,570
	8,971	8,960	9,488
	9,375	9,931	10,128
	9,338	9,819	9,686
	8,486	9,427	9,793
	8,035	9,959	9,430
	9,130	10,082	9,319
Average	9,094	9,716	9,373
18 x 23	9,000	8,919	9,304
	8,668	8,757	8,907
	9,352	9,099	9,252
	9,831	9,573	9,155
	9,544	9,044	9,096
	9,157	9,608	9,484
	9,612	9,353	9,103
	9,177	9,446	9,302
	9,566	9,865	9,050
Average	9,323	9,296	9,184
Grand Average	9,040	9,236	9,163

5% LSD for individual yields = 984; for averages of 9 yields = 328; for averages of 27 yields = 189. C.V. = 8.59

Table 16. Total of 3 dry matter yields (lb/acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 4 at Tifton, Georgia in 1970.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	8,510	7,757	7,316
	8,041	8,522	8,118
	8,357	8,059	7,983
	8,351	7,558	8,034
	7,659	7,676	7,805
	7,643	7,741	8,088
	7,675	8,521	7,975
	8,456	8,177	7,396
	7,727	7,667	8,278
Average	8,047	7,964	7,888
13 x 18	8,157	8,479	8,717
	8,546	8,437	8,957
	8,816	8,920	9,604
	9,079	8,956	5,940
	9,574	9,277	7,819
	9,048	9,155	7,783
	9,145	9,216	8,292
	8,163	8,465	8,406
	8,714	9,197	8,727
Average	8,805	8,900	8,249
18 x 23	8,496	8,787	8,591
	8,215	8,278	8,129
	7,791	8,430	8,218
	8,279	8,636	8,851
	8,704	8,244	8,901
	8,348	8,424	8,098
	7,688	8,050	8,494
	8,096	8,780	8,104
	8,836	8,068	8,265
Average	8,273	8,411	8,406
Grand Average	8,375	8,425	8,181

5% LSD for individual yields = 927; for averages of 9 yields = 309; for averages of 27 yields = 178. C.V. = 8.89

Table 17. Total of 3 dry matter yields (lb/acre) from 3 x 3 diallel crosses tested in 9 x 9 lattice square test No. 5 at Tifton, Georgia in 1970.

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	9,057	8,085	8,022
	8,158	7,959	8,297
	8,608	8,543	8,155
	8,186	7,864	7,918
	8,651	8,012	8,323
	8,231	7,967	7,711
	8,420	8,390	8,376
	8,744	8,027	8,298
	8,292	8,277	7,949
Average	8,483	8,125	8,117
13 x 18	8,995	9,853	8,946
	9,408	9,674	9,578
	9,626	7,834	9,893
	9,376	9,098	9,594
	9,655	9,310	9,839
	9,390	9,007	9,463
	9,250	9,926	9,104
	9,583	9,668	9,417
	8,853	9,462	9,229
Average	9,348	9,315	9,451
18 x 23	8,300	9,933	8,683
	9,489	8,600	8,678
	9,123	8,715	8,666
	8,865	8,947	8,808
	8,939	8,997	8,200
	8,488	8,963	8,647
	9,114	8,952	8,822
	8,357	8,572	8,415
	8,791	8,452	9,105
Average	8,830	8,903	8,669
Grand Average	8,887	8,781	8,746

5% LSD for individual yields = 900; for averages of 9 yields = 300; for averages of 27 yields = 173.   C.V. = 8.17

Table 18 . Total of 2 dry matter yields (lb/acre) from a 3x3 diallel crosses tested in 9 x 9 lattice square test No. 6 grown at Tifton, Georgia in 1970

Cross	Control	Thermal neutrons	Ethyl methane sulfonate
13 x 23	6,682	6,558	6,574
	6,134	6,903	6,972
	6,626	6,350	6,474
	6,513	6,758	5,827
	6,637	6,393	7,030
	6,704	6,223	6,552
	6,536	6,738	6,694
	6,582	6,385	6,129
	5,880	6,123	6,502
Average	6,477	6,492	6,528
13 x 18	7,908	7,162	7,931
	8,158	6,836	7,507
	7,799	7,534	7,931
	7,385	7,997	6,583
	8,167	6,306	6,666
	6,871	7,632	7,903
	7,503	8,201	6,246
	7,801	6,527	7,250
	7,452	7,869	7,797
Average	7,672	7,340	7,313
18 x 23	6,611	6,759	7,177
	7,323	7,423	7,168
	7,046	7,446	7,469
	7,646	6,929	6,484
	7,755	7,701	6,959
	7,464	7,390	6,818
	7,532	7,349	7,419
	7,194	7,544	7,314
	7,767	7,509	7,574
Average	7,371	7,339	7,154
Grand Average	7,173	7,057	6,998

5% LSD for individual yields = 851; for averages of 9 yields = 284; for averages of 27 yields = 164. C.V. = 9.60.

been very precise.

In Table 19 we have summarized the average yields from each 9 x 9 lattice square by seed treatment. The analysis of variance at the bottom of this table reveals that years was the highly significant variable and that the seed treatment and the year x treatment interaction were not significant variables. Thus, mutagen treatments that have materially increased the mutation frequency as evidenced by chlorophyll deficient counts have not affected the average yields of singlecrosses involving these lines.

In Table 1 there is listed three crosses, each of which contain the yields for a 3 x 3 diallel for each of the three treatments. We examined the 27 singlecrosses for each cross in each of the first 18 tables to ascertain the location of the top yielding singlecross in each and summarized this data in Table 20. In 1968 for example, the top yielding hybrid occurred in the control group ten times, the thermal neutron group four times and the ethyl methane sulfonate four times. Over the three year period this top yielding hybrid occurred in the control 18 times, in the thermal neutron group 23 times and the ethyl methane sulfonate group 13 times. Although these data have limited significance they do suggest that thermal neutron treated breeding material might be expected to give more top yielding hybrids than ethyl methane sulfonate treated breeding material.

We used the yield data in Tables 1 through 18 to calculate estimates of general and specific combining ability (additive and non-additive genetic

Table 19. Average yields of 3 x 3 pearl millet diallels tested in 9 x 9 lattice square tests at Tifton, Georgia - 1968 to 1970.

		Pounds per acre of dry forage seed treated with			
Year	Test No	Control	Thermal neutrons	Ethyl methane sulfonate	Average
1968	1	10,706	10,864	10,716	10,762
	2	11,807	11,987	11,876	11,557
	3	10,714	10,467	10,690	10,624
	4	11,218	10,899	11,097	11,071
	5	11,416	11,322	11,437	11,392
	6	11,766	11,544	11,669	11,660
Ave.		11,271	11,180	11,248	11,233
1969	1	9,523	9,786	9,739	9,683
	2	9,720	10,414	10,197	10,110
	3	10,110	10,038	10,138	10,095
	4	10,372	10,375	10,285	10,344
	5	10,167	10,115	10,207	10,163
	6	9,948	9,766	9,953	9,889
Ave.		9,973	10,082	10,086	10,047
1970	1	9,038	9,155	8,957	9,050
	2	9,338	8,995	9,190	9,174
	3	9,040	9,236	9,163	9,146
	4	8,375	8,425	8,181	8,327
	5	8,887	8,781	8,746	8,805
	6	7,173	7,057	6,998	7,076
Ave.		8,641	8,608	8,539	8,596
Grand average		9,962	9,957	9,958	9,959

Analysis of variance

Source	DF	E sq	M sq	F
Years	2	62,779,306	31,389,653.00	**
Treatment	2	276	137.81	.0004 NS
Y x T	4	108,542	27,135.62	.0818 NS
Error	45	14,912,815	331,395.89	------
Total	53	77,800,939	--------	------
	cf	5355,751,020		

Table 20. Number of 27-entry diallels involving the same cross in which the top yielding hybrid (not significant at the 5% level) occurred in different seed treatment groups.

	Number of top yielding hybrids occurring in group from seed treated with		
Year	Control	Thermal neutrons	Ethyl methane sulfonate
1968	10	4	4
1969	4	9	5
1970	4	10	4
Total	18	23	13

variance) to obtain data that would help to satisfy the major objective of this research project. These estimates tabulated in Tables 21,22 and 23 have been discussed individually in the annual report in the year for which the data were collected. A study of these data reveals that with one exception in Table 22 (an error explained by footnote) the additive and non-additive genetic variances are small. These variances are small because the yields of the nine single crosses in any 3 x 3 diallel were similar. The data in Tables 21, 22 and 23 also show a great lack of consistency in the magnitude of the additive and non-additive genetic variances. Further a great many of the variances (48 in 1968, 48 in 1969, and 45 in 1970) are negative. Negative variances are not supposed to exist and occur in these data because of the very small number of components in the diallel (9 singlecrosses) because of the similarity of yields of these nine singlecrosses and because of experimental error. Obviously a small sample of such data cannot be expected to reveal the true effect of thermal neutron and ethyl methane sulfonate seed treatments on general and specific combining ability of pearl millet. By averaging together enough of this data, one might hope to obtain a better indication of the effect of these mutagenic agents on the yield genes that influence additive and non-additive genetic variances.

The average annual variances that we have presented at the bottom of Tables 21, 22 and 23 have also lacked consistency. We have brought these averages together in Table 24 and have averaged them to obtain

Table 21. The effect of thermal neutrons and ethyl methane sulfonate on the general and specific combining ability (additive and non-additive genetic variance) of pearl millet inbreds as estimated from 3 x 3 diallel single-crosses. Total dry-matter yields in pounds per acre in 1968.

9 x 9 Lattice square test	Cross	Control				Thermal neutrons				Ethyl methane sulfonate			
		Diallel	Additive	Non-additive	% Non-additive	Diallel	Additive	Non-additive	% Non-additive	Diallel	Additive	Non-additive	% Non-additive
1	13 x 23	4	+ 85	+119	58	1	+ 89	- 70	0	7	- 3	+ 18	100
	13 x 239	5	+ 72	- 59	0	2	- 5	- 42	89	8	+ 26	+ 9	26
	239 x 23	6	- 58	+ 30	100	3	- 15	+ 19	100	9	- 66	+102	100
2	13 x 23	4	+415	+513	55	1	+ 66	+127	66	7	+ 73	- 17	0
	13 x 239	5	+ 41	- 88	0	2	+ 6	+ 23	79	8	- 12	- 58	83
	239 x 23	6	- 51	+ 20	100	3	+171	-119	0	9	+ 77	- 8	0
3	13 x 23	4	+159	+112	41	1	+ 28	- 13	0	7	-106	+223	100
	13 x 239	5	- 17	+ 19	100	2	- 22	- 16	42	8	+ 6	-115	0
	239 x 23	6	+ 29	+199	87	3	-127	+205	100	9	-202	+233	100
4	13 x 23	4	+139	-133	0	1	+196	+ 55	22	7	-116	+ 34	100
	13 x 239	5	+113	- 23	0	2	- 78	+128	100	8	+ 42	- 10	0
	239 x 23	6	- 14	- 85	86	3	+ 95	-148	0	9	- 4	-104	96
5	13 x 23	4	+ 48	- 93	0	1	+ 42	- 52	0	7	- 58	+ 42	100
	13 x 239	5	+125	- 88	0	2	+390	- 96	0	8	+ 76	+ 69	48
	239 x 23	6	+ 86	-125	0	3	-223	+199	100	9	+128	- 21	0
6	13 x 23	4	-101	+157	100	1	- 61	+203	100	7	+110	-100	0
	13 x 239	5	+186	+ 77	29	2	+464	- 13	0	8	- 78	+ 38	100
	239 x 23	6	+226	+ 53	19	3	-139	+179	100	9	+ 95	- 73	0
Average			+ 82	+ 34	43 29 1/		+ 48	+ 32	50 40 1/		- 67	+ 15	53 100 1/

1/ Calculated from the additive and non-additive averages.

Table 22. The effect of thermal neutrons and ethyl methane sulfonate on the general and specific combining ability (additive and non-additive genetic variance) of pearl millet inbreds as estimated from 3 x 3 diallel singlecrosses.

9 x 9 Lattice square test	Cross	Total dry matter yields in lbs. per acre in 1969 - Genetic variance as influenced by											
		Control				Thermal Neutrons				Ethyl Methane Sulfonate			
		Diallel	Additive	Non-Additive	% Non-Additive	Diallel	Additive	Non-Additive	% Non-Additive	Diallel	Additive	Non-Additive	% Non-Additive
1	13 x 23	4	+ 82	- 86	0	1	+ 41	- 47	0	7	- 8	- 51	86
	13 x 18	5	+ 64	- 2	0	2	-110	+126	100	8	+ 8	+ 1	11
	18x 23	6	+ 21	- 90	0	3	+ 47	+2664[2]	98	9	- 6	- 31	84
2	13 x 23	4	+805	+269	25	1	+115	- 60	0	7	-118	+104	100
	13 x 18	5	+127	- 66	0	2	+ 16	+ 97	86	8	+ 23	- 19	0
	18 x 23	6	- 40	- 11	22	3	+ 53	- 8	0	9	- 28	+ 36	100
3	13 x 23	4	+ 31	- 66	0	1	+ 37	- 44	0	7	-120	+182	100
	13 x 18	5	+ 18	- 39	0	2	+ 61	-127	0	8	+ 30	-123	0
	18 x 23	6	+221	+ 79	26	3	- 46	+ 5	100	9	+ 19	+ 66	78
4	13 x 23	4	- 13	- 47	78	1	- 55	+ 2	100	7	+ 70	+ 3	4
	13 x 18	5	+235	- 40	0	2	+ 14	- 8	0	8	- 19	+ 12	100
	18 x 23	6	+124	+220	64	3	- 63	+163	100	9	- 33	+ 32	100
5	13 x 23	4	+174	+ 67	28	1	+141	+ 26	16	7	- 62	+ 63	100
	13 x 18	5	+ 4	+ 19	83	2	+ 5	- 33	0	8	- 10	- 14	58
	18 x 23	6	-185	+292	100	3	+ 8	- 51	0	9	-222	+505	100
6	13 x 23	4	+171	+ 78	31	1	+137	+142	51	7	- 14	- 13	48
	13 x 18	5	+ 38	- 45	0	2	- 3	- 58	95	8	+ 61	- 47	0
	18 x 23	6	+ 7	- 58	0	3	+125	- 47	0	9	+158	- 3	0
Average			+105	+ 26	25 20[1]		+ 29	+ 5	41 15[1]		- 15	+ 39	59 100[1]

1/ Calculated from the additive and non-additive averages.

2/ Due to selfed progeny of 18 replacing one 18 x 23 cross, probably a result of making the cross with pollen that was too old.

Table 23. The effect of thermal neutron and ethyl methane sulfonate on the general and specific combining ability (additive and non-additive genetic variance) of pearl millet inbreds as estimated from 3 x 3 diallel singlecrosses.

9 x 9 Lattice square test	Cross	Total of three dry matter yields in lbs. per acre in 1970 - Genetic variance as influenced by: Control				Thermal neutrons				Ethyl Methane Sulfonate			
		Diallel	Additive	Non-Additive	% Non-Additive	Diallel	Additive	Non-Additive	% Non-Additive	Diallel	Additive	Non-Additive	% Non-Additive
1	13 x 23	4	+102	- 20	0	1	- 3	+ 16	100	7	- 21	- 2	8
	13 x 18	5	+244	- 16	0	2	+291	- 19	0	8	- 26	+116	100
	18 x 23	6	- 56	+121	100	3	+264	- 45	0	9	- 47	+ 78	100
2	13 x 23	4	+146	- 28	0	1	- 65	+ 23	100	7	+ 58	+ 30	34
	13 x 18	5	+ 10	+ 13	57	2	- 33	+442	100	8	- 49	+115	100
	18 x 23	6	-127	+363	100	3	+855	+ 9	1	9	+ 49	- 17	0
3	13 x 23	4	+136	- 65	0	1	-158	+150	100	7	+ 61	- 66	0
	13 x 18	5	+391	- 12	0	2	+221	- 68	0	8	+266	- 51	0
	18 x 23	6	+ 55	- 19	0	3	+175	-105	0	9	- 26	- 85	76
4	13 x 23	4	- 64	+115	100	1	+ 3	+ 62	95	7	- 64	+ 74	100
	13 x 18	5	+ 5	+163	97	2	+ 54	+ 5	8	8	+1348	+228	14
	18 x 23	6	-163	+196	100	3	- 83	+ 50	100	9	+ 46	- 17	0
5	13 x 23	4	- 93	+ 79	100	1	+ 17	- 56	0	7	+ 32	- 66	0
	13 x 18	5	- 11	- 3	21	2	+142	+302	68	8	+ 33	- 5	0
	18 x 23	6	-203	+239	100	3	+ 67	+ 81	55	9	+ 33	- 51	0
6[2]	13 x 23	4	- 70	+ 33	100	1	+ 53	- 73	0	7	-141	+177	100
	13 x 18	5	+188	- 26	0	2	+ 57	+ 89	61	8	+385	+209	35
	18 x 23	6	+ 73	+ 16	18	3	+113	- 87	0	9	+182	- 94	0
Average			+ 31	+ 64	49 67[1]		+109	+ 43	44 28[1]		+117	+ 32	37 21[1]

1/ Calculated from the additive and non-additive averages.
2/ Only 2 dry matter yields available for these determinations.

Table 24. Average additive and non-additive genetic variance estimated from total forage yields of 54 3 x 3 diallels tested in 9 x 9 lattice squares in 1968 - 1970.

Year	Genetic variance as influenced by								
	Control			Thermal neutrons			Ethyl methane sulfonate		
	Additive	Non-Additive	% Non Additive	Additive	Non-Additive	% Non Additive	Additive	Non-Additive	% Non Additive
1968	+ 82	+34	43	+ 48	+32	50	- 67	+15	53
1969	+105	+26	25	+ 29	+ 5	41	- 15	+39	59
1970	+ 31	+64	49	+109	+43	44	+117	+32	37
Ave	+ 73	+41	39	+ 62	+27	45	+ 12	+29	50
1968 1/			29			40			100
1969			20			15			100
1970			67			28			21
Ave			39			28			74
2/			36			30			71

1/ Calculated from annual additive and non-additive averages

2/ Calculated from 3 year additive and non-additive averages additive and non-additive genetic variances for the control of +73 and +41, for thermal neutrons of +62 and +27 and for ethyl methane sulfonate of +12 and +29. It is noteworthy that by averaging the three years data that we have been able to eliminate the negative variances (Table 24). If we average the percent of non-additive genetic variances for each of these three treatments based on the averages of individual calculations in each table (many of which were 0 or 100 because of the negative variances that are treated as 0's for such calculations) we find the percents of non-additive genetic variance for the control, thermal neutron and ethyl methane sulfonate treated material to be 39, 45 and 50 percent respectively. Percentages of non-additive genetic variances obtained by averaging together the percentages calculated from annual additive and non-additive averages are for the control, thermal neutron and ethyl methane sulfonate treatments 39, 28 and 74 percent respectively. If we calculate the percent of non-additive genetic variance from the three year additive and non-additive averages in Table 24 the percent of non-additive genetic variance with the control, thermal neutron and ethyl methane sulfonate treated material are 36, 30 and 71 percent respectively. These data indicate that as we average together more years of data of the type collected during the past three years, we may expect to find a greater consistancy in the results obtained. This type of analysis assumes that each effect regardless of how small it may be is a real effect and may logically be averaged with all other effects to give the final relationship required to satisfy our original objective.

There is another method of assessing this data that is worthy of consideration at this point. In each year we have been able to study yield responses of 324 lines (self-progeny of selected plants having undergone three cycles of recurrent treatments) as single crosses, components of 3 x 3 diallels. As these have been chosen at random, one would hardly expect all of them to have undergone change due to mutagenic treatment. Neither would one have expected all changes to have been great enough to have caused significant differences in forage yield or genetic variance. Thus, one might logically consider the additive and non-additive variances presented in Tables 21, 22 and 23 as prelimenary test to permit the selection of those lines in which changes have been great enough to significantly effect the additive and/or non-additive genetic variance. Since negative variances occur only as a result of error, it would seem logical to assume that positive genetic variances as large as the negative variances could also occur due to error. Following this reasoning only positive genetic variances greater than the largest negative genetic variance could be considered due to mutagens of the yield genes that affect additive and non-additive genetic variance for yield. Following this reasoning, we have placed in Table 25 the number of genetic variances larger than the negative variance for each year as influenced by each treatment. Thus out of the 324 lines

Table 25. Number of genetic variances larger than the largest negative variance in each annual genetic variance computations.

Year	Total genetic variance	Large genetic variances occurring in plant material from seed treated with: Control	Thermal neutron	Ethyl methane sulfonate	Total
1968	108	3	2	1	6
1969	107	4	1	1	6
1970	108	4	6	5	15
Total		11	9	7	27

tested each year, we obtained six large genetic variances in 1968, a similar number in 1969, and 15 in 1970 to make a total of 27 (we recognized that we have tested these lines only one year and that their performance in another year might not be the same). Even so, the lines involved in the singlecrosses giving these 27 large genetic variances over the past three years would seem to be those most likely affected by treatment. Likewise these lines might be those best able to show the effects of seed treatment on additive and non-additive genetic variances. To show the effects, one would need to include these lines in diallels and test them as we have tested other lines in previous years.

To test this hypothesis, we selected enough of the lines involved in the large additive and non-additive variances obtained in 1968 and 1969 to produce two 5 x 5 diallels of the cross 13 x 23. Seed of these diallels produced in 1970 will be tested in 1971 in two 9 x 9 lattice squares. In each lattice square there will be 25 single crosses coming from control seed, 25 coming from thermal neutron treated seed and 25 coming from ethyl methane sulfonate treated seed all having the same basic parental lines. We believe the use of the larger diallel will give us a better assessment of the additive and non-additive genetic variances and will reduce the likelihood of obtaining negative variances.

We also intend to continue the 3 x 3 yield trials in 1971 as in the past three years in order to obtain more material to average with the overall data, averaged in Table 24 as well as to screen for those lines capable of giving the largest genetic variances.

Evaluation of preliminary screening techniques for combining ability.

Using the 9 x 9 lattice squares, we have over the past three years been able to measure quite precisely the yields of 486 single crosses each year. In each 9 x 9 diallel however, we measured the yield of 9 single crosses in order to assess the performance of six lines. Our 9 x 9 lattice squares are replicated five times. If it were possible to use randomized block tests with only three replications, we would be able to screen a larger number of lines with the same effort. In order to assess this possibility in 1970, we established three randomized block experiments with three replications in which we tested 46, 60 and 30 singlecrosses that were also being tested in standard 9 x 9 lattice square experiments. The triplicated randomized block experiments were planted at the same time as the 9 x 9 lattice square experiments but were planted in a different field. Two yields were taken at essentially the same time in both tests. Correlation coefficients between the yields of these s inglecrosses when grown in the 9 x 9 lattice test and randomized block test calculated for the first cutting, second cutting and total are summarized in Table 26. All of these correlation coefficients were small ranging from -.05 to +.32 and were not significant. Thus it would appear that we cannot hope to successfully

Table 26. Correlation coefficients between yields of singlecrosses tested in 9 x 9 lattice squares with 5 replications and in randomized blocks with 3 replications in 1970.

Test No.	Singlecrosses tested	Correlation coefficients for 1st cutting	2nd cutting	Total
1	46	+.24	+.22	-.05
2	60	+.14	+.23	+.32
3	30	+.28	+.14	-.02

screen in a preliminary way singlecrosses in randomized block experiments replicated only three times.

We could increase the number of lines screened by 50% if it were possible to screen them as inbred lines rather than as parents of singlecrosses in 3 x 3 design II diallels. We could also increase the number of inbred lines evaluated per unit of input if we could take only one yield when lines were beginning to set seed instead of taking three yields. Obviously, we would need to establish close relationship between such a single yield and a three-yield total before this procedure could be followed with confidence. Significant yield differences between lines coming out of a single inbred line would be due to addtive genetic differences. These lines differing in additive effects could then be combined in 5 x 5 design II diallels to measure the relative amounts of additive and non-additive genetic variance resulting from such matings.

In 1971 we plan to evaluate the forage yields of at least 81 lines coming from inbreds having received the treatments being studied in this investigation. If we are successful in isolating lines that differ significantly in yield, we will consider pursuing differences until we have enough lines to produce 5 x 5 design II matings for a yield trial. We believe that this may be the most efficient way to arrive at our main objective to ascertain the effect of thermal neutron and ethyl methane sulfonate seed treatments on general and specific combining ability of pearl millet. If this procedure will work, we will be able to increase by 50% the number of lines that can be tested each year.

Evaluation of Inbreds for Response to Three Cycles of Recurrent Mutagen Treatments

Five inbred lines from the original 10 were selected for the second series of treatments. Each inbred traces back to a single plant, and each was very homozygous before treatments were applied. These inbreds were given 10 different treatments of thermal neutron radiation and chemical mutagens for three consecutive years. The thermal neutron doses are summarized (Table 27) for the three cycles. A low dose and a high dose was given each year and has been referred to in the table (Table 28). The two chemical mutagens were ethyl methane sulfonate (EMS) and diethyl sulfate (DS). The concentrations are footnoted (Table 28).

In order to ascertain whether the populations later to be involved in combining ability tests were adequately treated, the selfed progeny of the inbreds were evaluated for chlorophyll deficient seedling mutations after each cycle. The evaluation was based on three methods of recording the mutations, (1) plant basis giving number of mutations per plants tested, (2) head basis giving number of mutations per heads tested and (3) seedling basis giving the number of mutations per seedlings. The response of the Mutagen-2 (M2)generation to the treatments are reported by plants, head and seedling basis for the three cycles (Tables 29 - 37). The analysis of variance for each year is reported in Tables 38 through 40.

These data show the extent of the mutagen effects on the chlorophyll controlled genetic structure. In all 3 cycles a combination of high neutron radiation and low diethyl sulfate produced the most mutations (28% of plants - Table 35). The relative rankings for all three cycles are given in Table 41. Mutations were almost doubled from the first to the second cycle, but leveled off at the third cycle of treatments. Some inbreds showed a slight decrease in mutations during the third cycle of tests. Since several sources of seed were used for each inbred, we have reviewed the response for two sources of each, that were tested all 3 years (Table 42). Although the data are not very consistent because of smaller sample size, the third cycle of treatments have somewhat lower mutation rates than predicted from second cycle. However, rates up to 55%, found in some inbreds, will give excellent populations for later involvement in combining ability studies.

Table 27. Thermal neutron dosages given 5 inbred lines of pearl millet during three cycles of mutagen treatments.

Time	Flux	Total Dose
	1st cycle	
35 min.	3.16×10^9	6.63×10^{12}/cm^2/sec.
35 min.	3.18×10^9	6.67×10^{12}/cm^2/sec.
65 min.	3.88×10^9	1.51×10^{13}/cm^2/sec.
65 min.	3.84×10^9	1.49×10^{13}/cm^2/sec.
	2nd cycle	
30 min.	3.85×10^9	6.93×10^{12}/cm^2/sec.
30 min.	3.72×10^9	6.70×10^{12}/cm^2/sec.
65 min.	3.88×10^9	1.51×10^{13}/cm^2/sec.
66 min.	4.00×10^9	1.58×10^{13}/cm^2/sec.
	3rd cycle	
39 min.	2.99×10^9	6.99×10^{12}/cm^2/sec.
41 min.	2.50×10^9	6.15×10^{12}/cm^2/sec.
88 min.	3.03×10^9	1.59×10^{13}/cm^2/sec.
88 min.	2.77×10^9	1.46×10^{13}/cm^2/sec.

Table 28. Treatments of thermal neutron and chemical mutagens given to five inbred lines of pearl millet.

Coded treatment number	Treatment
1	Control
2	Low TN 1/
3	High TN
4	Low EMS 2/
5	High EMS
6	High TN + Low EMS
7	Low TN + High EMS
8	Low DS 3/
9	High DS
10	High TN + Low DS
11	Low TN + High DS

1/ Thermal neutron (TN) dosages given in Table 27.

2/ Low and High EMS refer to .2 and .4% ethyl methane sulfonate, respectively.

3/ Low and high DS refer to .1 and .2% diethyl sulfate, respectively.

Table 29. Effects of single and combined mutagen treatments on five inbred lines of pearl millet -- M_2 chlorophyll - deficient seedling mutations (Plant basis, % of total examined in 1967 of 1st cycle).

Treatments	Inbreds 23	239	13	7	18	Average
TN 60 + DS.001	14.5	15.0	12.2	14.0	14.2	13.99a[1/]
TN 30 + DS.002	17.3	14.1	9.9	13.7	13.3	13.66a
TN 30 + EMS.004	8.5	21.0	15.1	12.8	5.5	12.60a
TN 60 + EMS.002	10.6	10.9	12.5	12.5	12.0	11.69a
TN 60	15.5	15.6	14.2	4.2	7.6	11.43a
TN 30	8.9	8.4	9.7	12.3	15.7	11.01a
EMS.004	11.2	7.5	6.1	2.5	1.7	5.80b
DS.002	9.2	1.4	3.7	0.8	3.1	3.64bc
EMS.002	6.1	1.2	3.0	3.7	2.9	3.38bc
DS.001	2.2	4.0	4.4	3.4	1.5	3.11bc
Control	0.0	0.8	1.9	1.4	0.6	0.94c
Average	9.5a[1/]	9.1a	8.4a	7.4a	7.1a	8.29

[1/] Duncan's Multiple Range test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 30. Effects of single and combined mutagen treatments on five inbred lines of pearl millet - M_2 chlorophyll-deficient seedling mutations (Head basis, % of total examined in 1967 of 1st cycle).

Treatments	Inbreds 23	7	239	13	18	Average
TN 60 + DS .001	8.2	10.5	7.9	6.6	9.2	8.48a 1/
TN 60 + EMS .002	7.1	10.8	5.9	7.5	8.7	8.01a
TN 30 + EMS .004	5.2	7.0	11.5	8.9	3.3	7.18ab
TN 30 + DS .002	9.5	7.8	6.5	5.0	5.9	6.96ab
TN 60	9.8	2.6	8.3	7.0	3.9	6.34ab
TN 30	4.2	6.6	3.6	4.1	8.2	5.32b
EMS .004	6.6	1.4	3.8	3.2	0.7	3.16c
EMS .002	2.8	2.3	0.7	1.6	1.8	1.84cd
DS .001	0.8	2.3	1.8	2.1	1.2	1.64cd
DS .002	3.8	0.3	0.6	1.6	1.3	1.53cd
Control	0.0	1.8	0.3	1.2	0.8	0.83d
Average	5.27a 1/	4.86a	4.64a	4.43a	4.11a	-

1/ Duncan's Multiple Range test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 31. Effect of single and combined mutagen treatments on five inbred lines of pearl millet - M_2 chlorophyll-deficient seedling mutations (seedling basis, % of total examined in 1967 of 1st cycle).

	Inbreds					
Treatments	23	7	18	13	239	Average
TN 60 + EMS .002	1.6	2.2	2.2	1.6	0.8	1.68a[1/]
TN 60 + DS .001	1.5	2.3	1.4	1.0	1.2	1.48a
TN 30 + EMS .004	1.4	1.7	0.6	1.2	1.5	1.28a
TN 30 + DS .002	1.9	1.3	0.9	1.3	0.7	1.23ab
TN 60	1.4	0.3	0.5	0.9	1.1	0.82bc
TN 30	0.7	1.5	0.9	0.4	0.4	0.78c
EMS .004	1.6	0.3	0.0	0.2	0.5	0.54cd
EMS .002	0.5	0.4	0.4	0.2	0.0	0.30d
DS .002	0.7	1.1	0.2	0.2	0.1	0.27d
DS .001	0.2	1.2	0.3	0.1	0.0	0.16d
Control	0.0	0.3	0.2	0.1	0.1	0.15d
Average	1.06a[1/]	0.97ab	0.68b	0.65b	0.59b	-

[1/] Duncan's Multiple Range test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 32. M_2 generation chlorophyll-deficient seedling mutation rates (plant basis) after two cycles of mutagen treatments - 1968.

Treatment 1/	Inbreds					Average
	239 (5)	13 (3)	23 (2)	7 (1)	18 (4)	
10	.264	.438	.245	.161	.438	.241a 2/
3	.270	.197	.316	.183	.232	.240a
6	.271	.154	.257	.200	.189	.214a
11	.192	.212	.174	.239	.164	.196a
2	.197	.173	.154	.219	.120	.189a
7	.149	.227	.280	.173	.101	.186ab
5	.224	.113	.097	.126	.059	.123c
8	.020	.089	.037	.064	.041	.069d
4	.062	.010	.068	.115	.088	.050d
9	.064	.028	.010	.082	.064	.049d
1	.000	.052	.018	.061	.009	.028d
Average	.156a 2/	.154a	.150a	.147a	.113a	--

1/ Treatments coded. See Table 28.

2/ Duncan's Multiple Range Test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 33. M_2 generation chlorophyll-deficient seedling mutation rates (head basis) after two cycles of mutagen treatment - 1968 .

Treatment[1]	Inbreds					Average
	13 (3)	7 (1)	23 (2)	239 (5)	18 (4)	
3	.126	.095	.174	.161	.141	.140a[2]
10	.239	.087	.112	.138	.065	.128ab
6	.095	.112	.148	.125	.098	.115ab
11	.115	.129	.120	.095	.087	.107ab
7	.136	.112	.148	.076	.060	.106ab
2	.094	.120	.083	.089	.097	.096bc
5	.072	.071	.046	.122	.029	.068c
4	.004	.049	.034	.029	.055	.034d
8	.055	.046	.027	.011	.026	.033d
9	.029	.050	.004	.033	.030	.029d
1	.029	.034	.008	.000	.004	.015 d
Average	.090a[2]	.082a	.081a	.080a	.063a	--

[1] Treatments coded. See Table 28.

[2] Duncan's Multiple Range Test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 34. M_2 generation chlorophyll-deficient seedling mutation rates (seedling basis) after two cycles of mutagen treatments - 1968.

Treatment[1/]	Inbreds 7 (1)	23 (2)	13 (3)	239 (5)	18 (4)	Average
6	.0400	.0392	.0152	.0218	.0180	.0268a[2/]
10	.0290	.0282	.0382	.0240	.0118	.0262a
3	.0125	.0332	.0187	.0303	.0350	.0259a
7	.0317	.0342	.0330	.0107	.0055	.0230ab
2	.0417	.0138	.0150	.0090	.0168	.0193ab
11	.0268	.0315	.0098	.0117	.0093	.0178ab
5	.0162	.0097	.0102	.0338	.0330	.0146bc
4	.0087	.0083	.0003	.0028	.0078	.0056cd
8	.0095	.0022	.0045	.0010	.0040	.0042d
9	.0043	.0000	.0068	.0038	.0007	.0031d
1	.0053	.0003	.0033	.0000	.0008	.0020d
Average	.0205a[2/]	.0182a	.0141a	.0136a	.0103a	--

1/ Treatments coded. See Table 28.

2/ Duncan's Multiple Range Test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 35. M_2 generation chlorophyll-deficient mutation rates (plant basis) after three cycles of mutagen treatment - 1969.

	Inbreds					
Treatment[1]	23 (2)	18 (4)	239 (5)	7 (1)	13 (3)	Average
10	.394	.299	.231	.164	.313	.280a[2]
6	.342	.233	.196	.235	.150	.231ab
11	.234	.220	.206	.150	.110	.184b
7	.206	.168	.164	.200	.163	.180bc
3	.275	.173	.144	.179	.124	.179bc
2	.134	.112	.260	.172	.129	.161bc
5	.151	.119	.052	.109	.120	.110cd
4	.119	.063	.070	.104	.068	.085d
8	.034	.048	.062	.013	.091	.050d
1	.024	.046	.068	.059	.039	.047d
9	.057	.031	.058	.036	.010	.038d
Average	.179	.137	.137	.129	.120	--

[1] Treatments coded. See Table 28.

[2] Duncan's Multiple Range test. Averages with a common letter are not significantly different.

Table 36. M_2 generation chlorophyll-deficient seedling mutation rates (head basis) after three cycles of mutagen treatment - 1969.

	Inbreds					
Treatment[1]	23 (2)	239 (5)	18 (4)	7 (1)	13 (3)	Average
10	.216	.125	.172	.101	.210	.165a[2]
6	.181	.128	.125	.135	.073	.128ab
11	.111	.129	.130	.075	.053	.099bc
7	.091	.110	.095	.113	.078	.097bc
3	.156	.081	.089	.093	.066	.097bc
2	.077	.138	.066	.092	.052	.085cd
5	.068	.029	.077	.063	.077	.063cde
4	.063	.049	.045	.060	.035	.051def
8	.014	.035	.029	.014	.050	.028ef
1	.017	.031	.021	.040	.025	.027ef
9	.027	.027	.015	.020	.004	.019f
Average	.093	.080	.078	.073	.065	---

[1] Treatments coded. See Table 28.

[2] Duncan's multiple range test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 37. M_2 generation chlorophyll-deficient seedling mutation rates (seedling basis) after two cycles of mutagen treatments-1969.

	Inbreds					
Treatment[1/]	23 (2)	7 (1)	239 (5)	18 (4)	13 (3)	Average
10	.0425	.0237	.0330	.0227	.0232	.0291a[2/]
6	.0355	.0290	.0295	.0375	.0112	.0286a
3	.0272	.0252	.0282	.0155	.0072	.0207ab
7	.0145	.0285	.0115	.0117	.0087	.0150bc
11	.0177	.0092	.0145	.0227	.0072	.0143bc
2	.0117	.0120	.0125	.0062	.0085	.0102cd
5	.0075	.0085	.0040	.0080	.0055	.0067cd
4	.0110	.0030	.0040	.0087	.0042	.0062cd
8	.0020	.0015	.0030	.0025	.0102	.0039d
1	.0010	.0060	.0007	.0015	.0040	.0027d
9	.0035	.0025	.0017	.0005	.0000	.0017d
Average	.0158	.0136	.0130	.0125	.0082	--

1/ Treatments coded. See Table 28.

2/ Duncan's Multiple Range Test. Averages with a common letter are not significantly different at the 5% level of probability.

Table 38. Analysis of variance of single and combined mutagen treatments of five inbred lines of pearl millet (1967 M_2 of 1st cycle).

		Mean squares of variables			
		Germination	Chloro.-def. seedling mutations		
Source	d.f	100 seeds planted	Per plant	Per head	Per seedling
Main Plots					
Reps (R)	1	37.50	.007826	.000043	.000003
Inbreds (I)	4	6546.55	.009385	.001696	.000384
R x I (Error a)	4	211.98	.004805	.001791	.000058
Subplots					
Seed Source (SS)	3	179.02	.019071	.003751	.000095
I x SS	12	150.01	.011925	.003844	.000188
R x I x SS (Error b)	15	82.05	.008209	.002863	.000096
Sub-Subplots					
Treatments	10	635.82	.096617	.033798	.001229
I x T	40	92.27	.008035	.003071	.000115
SS x T	30	46.91	.005986	.001897	.000098
I x SS x T	120	45.26	.007263	.002473	.000125
Error C	200	31.51	.005443	.001947	.000090

Table 39. Analysis of variance of M_2 generation chlorophyll-deficient seedling mutation rates after 2nd cycle of mutagen treatments - 1968.

		Mean square of variables		
		Chlorophyll-deficient seedlings		
Source	d.f	Plant Basis	Head Basis	Seedling Basis
Main Plots				
Reps (R)	1	.0008	.0001	.0000
Inbreds (I)	4	.0205	.0067	.0012
R x I (Error a)	4	.0181	.0031	.0007
Sub Plots				
Seed Source (SS)	2	.0139	.0047	.0005
I x SS	8	.0042	.0020	.0002
Error b	10	.0078	.0037	.0005
Sub-Sub Plots				
Treatments (T)	10	.2016	.0603	.0030
I x T	40	.0196	.0055	.0005
SS x T	20	.0090	.0030	.0002
I x SS x T	80	.0086	.0028	.0003
Error c	150	.0113	.0038	.0003

Table 40. Analysis of variance of M_2 generation chlorophyll-deficient seedling mutation rates after 3rd cycle of mutagen treatments-1969.

		Mean square of variables		
		Chlorophyll-deficient seedlings		
Source	d.f.	Plant Basis	Head Basis	Seedling Basis
Main Plots				
Reps (R)	1	.0163	.0051	.00029
Inbreds (I)	4	.0227	.0044	.00034
R x I (Error a)	4	.0207	.0110	.00021
Sub Plots				
Seed Source (SS)	1	.0496	.0144	.00049
I x SS	4	.0077	.0025	.00022
Error b	5	.0205	.0052	.00011
Sub-Sub Plots				
Treatments (T)	10	.1287	.0418	.00195
I x T	40	.0081	.0030	.00013
SS x T	10	.0086	.0031	.00019
I x SS x T	40	.0136	.0042	.00019
Error c	100	.0106	.0035	.00017

Table 41. Rankings of treatments effects on all inbred lines during 1st, 2nd and 3rd cycle for chlorophyll deficient seedlings.

1st cycle			2nd cycle			3rd cycle		
Plant	Head	Seedling	Plant	Head	Seedling	Plant	Head	Seedling
10a[1/]	10a	6a	10a	3a	6a	10a	10a	10a
11a	6a	10a	3a	10ab	10a	6ab	6ab	6a
7a	7ab	7a	6a	6ab	3a	11b	11bc	3ab
6a	11ab	11ab	11a	11ab	7ab	7bc	7bc	7bc
3a	3ab	3bc	2a	7ab	2ab	3bc	3bc	11bc
2a	2b	2c	7a	2bc	11ab	2bc	2cd	2cd
5b	5c	5cd	5b	5c	5bc	5cd	5cde	5cd
9bc	4cd	4d	4c	4d	4cd	4d	4def	4cd
4bc	8cd	9d	8c	8d	8d	8d	8ef	8d
8bc	9cd	8d	9c	9d	9d	1d	1ef	1d
1c	1d	1d	1c	1d	1d	9d	9f	9d

1/ Duncan's Multiple Range test. Averages with a common letter are not significantly different at the 5% level.

Table 42. Average number of mutations per plant for two different seed sources during 3 cycles of mutagen treatments.

	Inbred 7 (1)					
	Source 1			Source 2		
Treatments	1st	2nd	3rd	1st	2nd	3rd
10	.000	.146	.128	.160	.218	.120
6	.147	.135	.121	.118	.258	.349
7	.071	.152	.338	.087	.191	.062
11	.088	.282	.140	.100	.253	.161
3	.161	.227	.207	.000	.190	.151
2	.025	.175	.192	.189	.248	.151
5	.045	.153	.072	.025	.099	.145
4	.096	.088	.073	.029	.180	.135
8	.000	.053	.012	.054	.025	.014
9	.000	.079	.042	.000	.000	.031
1	.054	.067	.103	.000	.055	.014
Average	.0625	.1415	.1298	.0692	.1561	.1212

Continued

Table 42 (con't). Average number of mutations per plant for two different seed sources during 3 cycles of mutagen treatments.

	Inbred 23 (2)					
	Source 1			Source 2		
Treatments	1st	2nd	3rd	1st	2nd	3rd
10	.178	.229	.236	.205	.315	.551
6	.100	.394	.421	.088	.211	.262
7	.083	.246	.231	.208	.329	.180
11	.233	.172	.286	.214	.143	.182
3	.182	.323	.136	.124	.256	.415
2	.083	.156	.068	.104	.127	.201
5	.166	.102	.138	.129	.188	.164
4	.045	.109	.093	.107	.095	.144
8	.000	.048	.000	.089	.063	.067
9	.118	.030	.056	.214	.000	.059
1	.000	.034	.000	.000	.000	.048
Average	.1080	.1674	.1514	.1347	.1570	.2066

Continued

Table 42 (con't). Average number of mutations per plant for two different seed sources during 3 cycles of mutagen treatments.

	Inbred 13 (3)					
	Source 1			Source 2		
Treatments	1st	2nd	3rd	1st	2nd	3rd
10	.142	.422	.237	.059	.548	.388
6	.178	.225	.166	.110	.163	.135
7	.155	.254	.062	.130	.188	.264
11	.062	.243	.020	.232	.206	.200
3	.163	.110	.159	.151	.134	.088
2	.055	.160	.123	.031	.188	.134
5	.000	.167	.106	.024	.089	.134
4	.051	.000	.067	.035	.000	.069
8	.029	.125	.168	.080	.109	.015
9	.031	.000	.000	.033	.025	.020
1	.025	.031	.027	.053	.068	.052
Average	.0810	.1579	.1032	.0853	.1561	.1363

Continued

Table 42 (con't). Average number of mutations per plant for two different seed sources during 3 cycles of mutagen treatments.

	Inbred 18 (4)					
	Source 1			Source 2		
Treatments	1st	2nd	3rd	1st	2nd	3rd
10	.202	.153	.288	.205	.000	.310
6	.000	.071	.222	.083	.171	.244
7	.000	.166	.182	.055	.000	.154
11	.033	.188	.151	.031	.109	.289
3	.038	.359	.122	.214	.133	.224
2	.175	.201	.039	.120	.207	.185
5	.000	.053	.118	.038	.032	.120
4	.000	.000	.014	.090	.236	.113
8	.000	.056	.030	.000	.000	.066
9	.026	.027	.015	.000	.034	.048
1	.000	.000	.026	.000	.028	.067
Average	.0431	.1158	.1097	.0760	.0864	.1655

Continued

Table 42 (concluded). Average number of mutations per plant for two different seed sources during 3 cycles of mutagen treatments.

	Inbred 239 (5)					
	Source 1			Source 2		
Treatments	1st	2nd	3rd	1st	2nd	3rd
10	.052	.222	.306	.256	.182	.156
6	.083	.343	.247	.131	.223	.145
7	.205	.179	.121	.261	.238	.209
11	.237	.138	.178	.117	.306	.235
3	.241	.338	.077	.101	.216	.211
2	.101	.146	.158	.079	.220	.362
5	.059	.248	.090	.130	.313	.015
4	.000	.053	.083	.022	.049	.057
8	.024	.028	.109	.026	.000	.016
9	.056	.059	.046	.000	.100	.070
1	.000	.000	.057	.000	.000	.079
Average	.0962	.1595	.1338	.1021	.1679	.1414

Cytogenetics of Mutagen Treated Pearl Millet Inbreds

During the past three years we have gained a much better understanding of the cytogenetic variations that occur in mutagen treated and control plantings of pearl millet. Two of the inbreds selected for treatment carried homozygous chromosome interchanges (Inbred 13 and 239). Although these translocations have no consequence in evaluating forage yield, they do have important significance, when seed is produced commercially. A reduction of 40% seed-set can be expected in a plant with a heterozygous chromosome translocation. Many new chromosome interchanges are being located in the test material, providing an excellent group of chromosome markers. We have only begun to intercross some of these to determine their relationships.

Polyembryony, previously unrecognized, was discovered in pearl millet. The initial observation led to a series of discoveries, all related to this phenomenon. A twin plant was found with both sides having only half the complement of chromosomes (7). The haploid twin permitted as to recognize its unique characteristics, thereby permitting additional haploids to be found. This past season we found 7 haploid plants in the Tift 23 inbred .

From seed set on haploid plants, we located trisomic (2n = 15).

Recognition of trisomics in this material helped to initiate a search whereby a trisomic series will be established in pearl millet.

Genetic male sterility has been observed in the mutagen treated material and at least one source is genetically controlled by a single factor. Other sources are being investigated. Many of the male sterile types, however, have associated with them certain chromosome irregularities. The knowledge gained about cytologically related behavior will certainly aid the breeding improvement of this plant. Hopefully, it also will be useful in permitting a sound interpretation of detectable changes in combining ability.

Useful By-Products from this Research

A number of mutants coming out of this research are useful in our overall program of genetic and breeding research. Examples of these follows:

a. Early maturing mutants. In the summer of 1969, we discovered a true breeding early mutant in one of the lines of inbred 13 treated with thermal neutrons. In early November, 1969, while consulting for the Ford Foundation in West Pakistan, I discovered that farmers living on the edge of the desert grow pearl millet as their stable food crop in catchments at the bottom of slopes that accumulate water from a single rain. Very frequently, only one rain is available to make a crop of millet. It seemed logical that shortening the number of days from planting to maturing seed by substituting early maturing varieties, should increase the yields of seed and the dependability of the crop under such circumstances. However, I saw no early maturing pearl millet in West Pakistan. In order to breed such millets, I sent seed of three of the best Pakistan varieties of pearl millet to Dr. J. B. Powell and asked him to hybridize them with our early 13 mutant in the greenhouse and then grow and produce selfed seed on the F_1 generation of these crosses in the greenhouse. This he was able to do, so that by the summer of 1970, I was able to send back to West Pakistan millet breeders, seed to plant F_2 populations from which they could select in the summer of 1970 early maturing varieties that should breed true for earliness. Needless to say, the Pakistanians were impressed with the rapidity with which we were able to help them solve their problem. Our study of F_2 populations of these and other crosses at Tifton in the summer of 1970 reveals that the early mutant in inbred 13 differs from the normal 13 largely by a single recessive gene. Early lines that we have selected from the world gene pool have differed from normal lines by several genes. Thus it would have been much more difficult to transfer early maturity to another variety using these natural sources for earliness than using the mutant 13 source with its simple inheritance.

b. Dwarf mutants. All pearl millet grown for forage and grain around the world at the present time is of the tall type. However, as growing conditions are improved and hybrids are developed, dwarf types will be needed to facilitate the harvest of grain. We have research to indicate that the forage quality of pearl millet in the boot stage can be materially improved by introducing a dwarf gene that would reduce the percentage of stem in the forage. At the present time dwarfing is being accomplished by introducing a dwarf gene that occurred naturally in pearl millet. We believe that there may well be a need for larger and smaller dwarfs such as the kind that are currently appearing in irradiated and chemically treated material in this project. Thus we hope to assess the economic value of some of the most promising of these dwarf mutants.

c. <u>Chlorophyll deficient mutants.</u> This research project is producing a great many new and different chlorophyll deficient mutants. These will be very useful in mapping the chromosomes of pearl millet. This useful genetic procedure of mapping chromosomes has been neglected in pearl millet to date largely because of the lack of sufficient numbers of good genetic characters.

We have also worked out a technique of using some of the different chlorophyll deficient mutants occurring in inbred 23 to map heterotic areas on chromosomes in hybrids between 23 and other inbred lines. Inbred 23 in the male sterile form is used as a female to produce practically all of the millet forage and grain hybrids in the world today. We believe that our technique of mapping heterotic areas in the chromosomes in this line will have much academic interest and may have practical significance as well.

Evaluation of Low Dose Radiation (2 years)

The effect of exposing seed to gamma rays on the forage yields of three pearl millet genotypes was determined in the summers of 1969 and 1970. Each genotype treatment interaction was repeated three times in a 9 x 9 lattice square design to give a total of 15 plots for each treatment. Good stands and good growth of each genotype combination were obtained both years. The results warrant the following conclusions. The precision of the experiments was acceptable giving a CV for error for total forage yield for 7.98% in 1969 and 8.19% in 1970.

The total forage production for Millex 22 and hybrid Tift 23 x 186 was 6.8 and 18.8% greater than Gahi 1 in 1969 and 3 and 13% greater than Gahi 1 in 1970.

Irradiation did not significantly increase the forage yields of any one of three genotypes in either year.

As in 1969, irradiation of millet seed in 1970 with 19,200 R significantly reduced the forage yield of the first harvest but did not effect significantly the yield of second harvest. The effect on the first harvest was great enough that the 19,200 R treatment reduced the total forage yield for the year for the average millet, by 5.3% below the control in 1969 and 12.4% below the control in 1970.

Although the genotype times dosage interations were not significant in either year, there was evidence to indicate in both years that hybrid 23 x 186 was less susceptible to radiation injury capable of reducing yields than the other two genotypes in the test.

SUMMARY

Additive and non-additive genetic variances during the three years of tests have been small within individual 3 x 3 Design II diallels. They are small, because yields within the 3 x 3 diallels were similar. Negative variances were found for many of the diallels indicating that the 3 x 3 diallels are useful for screening, but larger diallels are needed for final testing. Assuming that each effect (regardless of how small) is a real effect, we logically can average these for the three years. When this is done, we found that percents of non-additive genetic variance for control, thermal neutron and ethyl methane sulfonate-treated material to be 39, 45 and 50 respectively for individual calculations and 39, 28 and 75 respectively for annual average calculations. Further calculations by averaging the three years resulted in percent non-additive genetic variances in the control, thermal neutron and ethyl methane sulfonate treatments of 36, 30 and 71 percent respectively. As more years of data of the type collected during the past three years is averaged together, we are finding greater consistency in the results.

Studies of the genetics and cytogenetics of treatments effects have produced numerous important findings in this crop. The publication of the results, as can be noted in the list of publications associated with research on this contract, documents these findings.

PROFESSIONAL TRAINING ASSOCIATED WITH CONTRACT

No graduate students or post-doctoral fellows have been trained or supported by this contract.

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DIVISION OF FEDERAL AND OTHER STATE OR PRIVATE INSTITUTIONAL SUPPORT

The University of Georgia's Coastal Plain Experiment Station Grass Breeding Section within the Agronomy Department as listed to supply additional support, is actually supported by the above-mentioned Station and the Crops Research Division, Agricultural Research Service, USDA. Three staff members, including G. W. Burton, have a part of their salaries paid by each organization. There are also full-time federal and full-time state people working in this cooperative effort. The state and USDA objectives are one and the same, and reports of all activities go to both agencies. The USDA contribution to salaries will be approximately $23,000.