herbicide was thoroughly mixed into the soil. Approximately 9000 M_2 seed was sprinkled onto the soil surface. The soil was packed and covered with a thin layer of silica sand. After 3 weeks, plants which had developed at least one true leaf were transplanted to untreated soil and allowed to produce open pollinated M_3 seed. A total of 243,000 M_2 seeds from five Brassica cultivars were screened.

Progeny Testing:

As M_3 seed became available, a primary progeny test was performed in the greenhouse. Three replicates of six seeds of each selection were planted in a row in a 35 x 60 cm flat. The cultivar Cascade was used as a control. Seedlings were allowed to grow for 10 to 14 days (2 to 4 true leaf stage) prior to post emergence SU applications. On the same date, a second identical test was planted treated with preemergence SU applications. Both the post and preemergence tests were treated in a spray chamber with the maximum recommended field rate of 26.3 g ai/ha Finesse^R. R-11 was added at 0.0533 ml/20 ml dilute solution as a surfactant for post emergence applications. After 2 to 3 weeks the selected lines were scored for resistance. Resistant seedlings were transplanted into untreated soil, vernalized and allowed to set open pollinated M_4 seed. M_4 seed from each M_3 plant was subjected to a similar secondary progeny test.

Growth Response of Resistant Selections:

On September 26, 1990 M_4 seed from 6 selected lines and the Cascade control were planted in 35 x 60 cm greenhouse flats filled with Sunshine^R potting soil. Five seeds of each line were planted in each of three replicates . A second, identical test was planted at the same time. Three flats from each set were treated preemergence with 7 rates of Finesse^R in a spray chamber. The seven rates of 0,2,4,8,16,32 and 64 g ai/ha were applied in dilute aqueous solution at 140 l/ha. The two experiments were placed in different areas of the greenhouse. Sixteen days and nineteen days after planting the two experiments were harvested. The number of nodes, number of emerged plants and dry weight were recorded. The study was conducted as two separate, split plot randomized block designs with three replicates each.

RESULTS AND DISCUSSION

Growth Response Study:

Herbicide rate, cultivar and the cultivar x rate interaction had a significant effect on all three indices (Table 1). The differences in the indices observed between varieties were probably the result of varietal characteristics as much as differential response to the herbicide. Interactions for all indices occurred only at herbicide rates lower than 32 ppb ai. At the higher rates, cultivar differences disappeared. The average percent of emergence declined from 92% in the control to only 59% as herbicide rates increased to 128 ppb ai Finesse^R, which was slightly higher than normal field use rate. As the rate of Finesse^R increased, the mean number of nodes produced decreased. At the rates of 32, 64, and 128 ppb ai, the seedlings only rarely produced true leaves. Average dry weight of the seedlings showed a dramatic decrease as the rate of Finesse^R was increased. Seedlings exposed to 16 ppb ai showed almost the same growth suppression as those exposed to the highest rate of 128 ppb ai. The results of this experiment were used to develop a screening procedure to isolate individual SU resistant M_2 seedlings. Since dry weight and number of nodes did not decline significantly at

herbicide rates above 32 ppb ai of Finesse^R, it was determined that seedlings could be screened in the greenhouse using a preplant application of 32 ppb ai Finesse^R. Seedlings which developed true leaves were selected for seed increase and progeny testing.

Screening of Mutant Populations:

Of the 243,000 seeds screened from April 1989 to November 1990, only 178 plants were selected for progeny tests (Table 2). Only those seedlings which developed true leaves were selected. The proportion of seedlings selected ranged from 1/600 in the M_2 Bridger population to just 1/27,000 in the M_2 R-500 population. These differences between cultivars reflect the random occurrence of mutations which condition SU herbicide resistance.

Progeny Tests:

Of 178 M_2 selections made in the initial screening only 59 have been progeny tested. Twenty-seven selections produced M_3 seed with some level of resistance to preemergence applications and 15 selections had resistance to post emergence applications of Finesse^R (Table 3). Twenty-five plants failed to produce seed indicating sterility or mortality caused by multiple induced mutations. Ninety-four selections have not been tested with preemergence progeny tests and 122 with post emergence progeny tests. Mutants which showed resistance to preemergence herbicide applications did not necessarily show resistance to post emergence applications. The selection, SUR 23, had resistance to preemergence applications of 26.3 g ai/ha Finesse^R (maximum recommended field rate), but was susceptible to a post emergence application of 10.5 g ai/ha (minimum recommended field rate). This differential response could be due to a root specific, SU resistant, ALS enzyme; root specific herbicide metabolism; failure to absorb the herbicide; or failure to translocate the herbicide to the ALS enzymes located in the chloroplasts.

Growth Response of Selected Mutants:

Evaluation of seven mutant lines and the Cascade control at seven rates of Finesse^R showed a broad range of responses to increasing herbicide rates. Both dry weight and number of nodes produced by SUR 23 RJ were significantly higher than the Cascade control at all rates up to the maximum of 64 g ai/ha Finesse^R, which is four times the normal recommended application rate (Fig. 1 and 2). At the highest rate of Finesse^R, SUR 23 RJ seedlings continued to grow and would have produced seed while the Cascade seedlings were morbid. Other selected lines showned intermediate levels of resistance to Finesse^R.

Segregation for resistance was still apparent in several of the selected M_4 lines. Individual plants with no symptoms of herbicide damage were selected for increase to the M_5 generation for further tests. It is hoped that mutants with preemergence resistance but post emergence susceptibility to SU herbicides will allow commercial application of these highly effective herbicides in cereal grain/rapeseed rotations.

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Table 1. Emergence, number of nodes and dry weight of 12 cultivars of rapeseed exposed to seven rates of Finesse[R].

Treatment/Source	Emergence	Number Nodes	Dry Weight
	---- % ----	-- No --	-mg plt^{-1}-
Herbicide Rate (ppb):			
0	92	6.3	140
4	90	5.0	64
8	83	3.4	17
16	80	2.0	10
32	73	1.1	8
64	66	1.0	6
128	59	1.0	5
$LSD_{(0.05)}$	8	0.2	9
	Analysis of Variance		
Source of Variation:	---------- F values ----------		
Herbicide Rate	121.9**	871.2**	302.6**
Cultivar	46.0**	11.7**	13.5**
Rate X Cultivar	4.2**	4.5**	9.0**

** F values significant at the 0.01 level of probability.

Table 2. Cultivar, Brassica species, number of M_2 seeds screened, number of SU resistant M_2 seedlings selected and the proportion of selected plants from populations treated with 5% ethyl methanesulphonate (EMS).

Cultivar	Species	M_2 Seeds Screened	M_2 Seedlings Selected	Proportion Selected
		-- No --	-- No --	
Cascade	B. napus	108,000	84	1/1,286
Cathy	B. napus	36,000	42	1/857
Bridger	B. napus	18,000	30	1/600
R-500	B. rapa	27,000	1	1/27,000
Tilney	B. hirta	54,000	21	1/2,571
Total		243,000	178	1/1,365

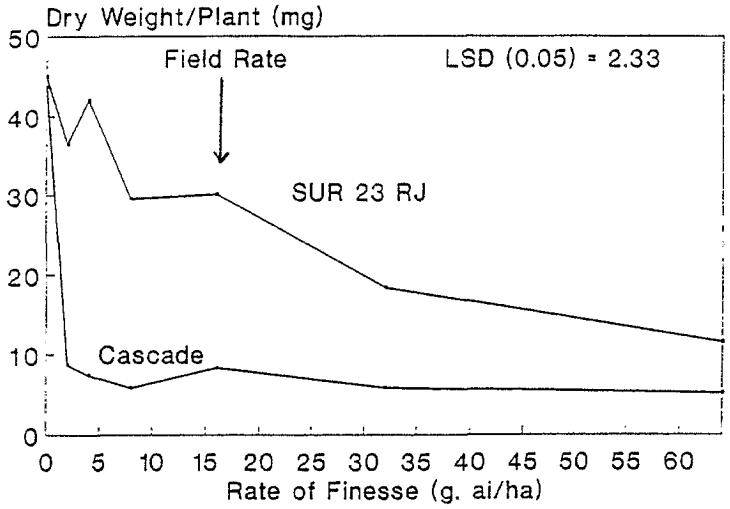

Figure 1. Average dry weight per plant of the Cascade control and the selected mutant SUR 23 RJ grown at seven rates of Finesse^{R} herbicide.

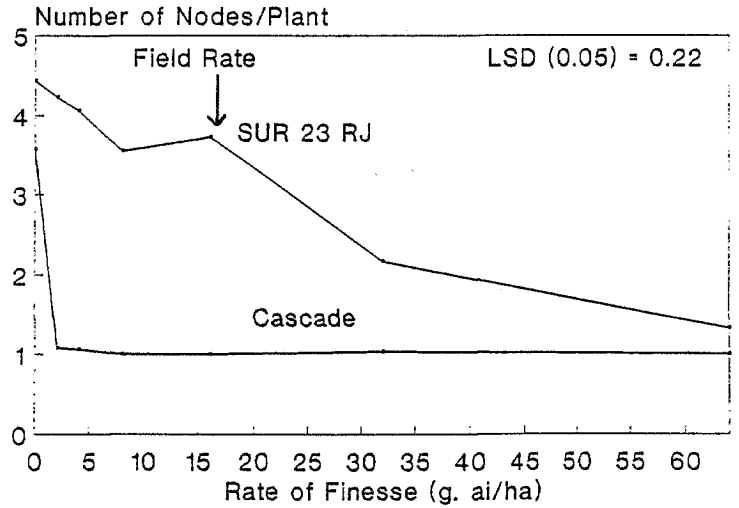

Figure 2. Average number of nodes per plant of the Cascade control and the selected mutant SUR 23 RJ grown at seven rates of Finesse^{R} herbicide.