BOWERS, DON*, DEL TRAVELLER, DENNIS SEARLE, CHARLES L. PETERSON, JOE THOMPSON, and R. V. WITHERS. First three authors, the Amalgamated Sugar Co., P.O. Box 1766, Nyssa, OR 97913; latter three authors, Agricultural Engineering, University of Idaho, Moscow, ID 83843. - Low cost pile covering.

The method for maintaining quality sugar beets in the storage pile has been an ongoing concern. In the fall of 1985, a pilot program was started by the Amalgamated Sugar Company under the direction of company agronomist Del Traveller and Charles L. Peterson, University of Idaho Agricultural Engineering Department. In 1988, the pilot program was extended to covering an entire pile with a silver-colored plastic, and a row of fans was placed down the center of the pile to exhaust the warm air out of the pile. The skirting of the pile was left up 4 feet to allow cool air to be circulated into the pile and out the top through the exhaust fans. We have worked with this method and feel that the results have been beneficial, even with the short storage period (47 days) that we have had for the past 2 years. The factory data for the 1988-89 crop computed to a savings of 133,000 lb of sugar, with a value of $29,300.00, or $1.17 per ton on the 25,000 ton test pile.

The production of sugarbeets is limited in California by the presence of rhizomania, a viral disease (beet necrotic yellow vein virus) transmitted by a soil-borne fungus, Polymyxa betae Keskin. Growers currently have no proven management schemes to encourage the planting of rhizomania infested fields.

The introduction of rhizomania tolerant experimental hybrids is increasing but their use has produced variable results. The recognized commercial tolerant variety, Rhizosen, is susceptible to another serious disease, curly top, limiting its use in some of the most severely infested soils. The use of Telone II fumigation, widespread prior to 1990, produces variable results from field to field for unknown reasons. The temporary suspension of the Telone II registration in California leaves growers without fumigation as an option for the foreseeable future. Cultural practices, such as planting beets earlier in the year before soils warm and Polymyxa becomes active, are thought to have an affect on disease development.

Field scale trials were begun in 1988 using fumigation and available tolerant varieties with normal grower practices in known rhizomania fields. Trials in 1989 and 1990 tested newer tolerant varieties in combination with fumigation and cultural practices thought to discourage rhizomania disease development. The objective of these evolving studies is to provide growers with a management scheme that will allow the profitable production of sugarbeets in known rhizomania fields.

The data from three trials in 1988 (to be published) were quite variable. Two of the trials were in fields that had been planted to sugarbeets the previous year. Curly top and high temperature rhizomania induced rots were contributors to poor yields. In general, late planting (April) contributed both to increased curly top losses and probably increased rhizomania losses. Planting beets in successive years is not a normal occurrence in California and may have contributed to serious losses to root rotting organisms.

1990 TRIALS

The encouraging yields in 1989 were still borderline in terms of growers monetary return. Changes were made in 1990 to try to obtain yields that would encourage growers to fumigate and use tolerant varieties. Newer broadly adapted hybrids with rhizomania tolerance were tried in addition to the rhizomania tolerant standard, Rhizosen.

The effectiveness of Telone II fumigation is increased with dry soil conditions. This requirement and the desire to plant earlier in the year (Jan-Feb) promoted a fall fumigation. In this way growers could avoid wet soil conditions that delay fumigation and subsequent planting. Earlier planting is thought to lead to increased yields due to the dormancy of Polymyxa betae under cool conditions and reduces the potential damage of curly top virus.

The two 1990 trials were established in October of 1989. Fumigant treatments were applied using commercial equipment and normal cultural practices. Soil conditions for fumigation were considered optimal in the heavy clay loam soils in 1990.

The varieties used in 1990, besides SS-LS2 and Rhizosen, were newer experimental varieties with rhizomania tolerance from Spreckels Sugar Company and Betaseed, Inc. Beta 4581 performed well in a rhizomania infested soil in the Salinas Valley in 1989 and was available on a semi-commercial basis. The Spreckels entries, H88292, SS-181R and SS-334R all offered California Central Valley adaptations to hot weather, curly top and other disease pressure and poor soils. As in 1989, sugarbeet seedlings were commercially thinned to leave approximately 35,000 per acre.

TABLE 3. Significance Levels from the Fumigation/Variety Trial in 1990

TRAIT	TREATMENT[1]	ENTRY[2]	TRT X ENT[3]
TS/A	NS	**	NS
TB/A	*	**	NS
% S	NS	*	*
% ROT	NS	**	NS

*,** Significant at alpha = 0.05, 0.01, RESP.

[1] Check, 9, and 12 Gallons/Acre Telone II (1,3-dichloropropene)
[2] SS-LS2, Rhizosen, SS-181R, SS-334R, H88292, BETA 4581
[3] Treatment x Entry Interaction

TABLE 4. Sugarbeet Yield, Sugar Content and Percent Rot in Rhizomania Infested Soil -- Summary of Varieties, 1990

VARIETY	TS/A	TB/A	% SUGAR	% ROT
SS-334R	1.79A	22.4B	10.1BC	17A
H88292	1.73A	25.0A	9.3D	19A
BETA 4581	1.58B	19.3C	10.3B	33B
SS-181R	1.40C	19.0C	9.8C	19A
RHIZOSEN	1.22D	14.4D	10.7A	49C
SS-LS2	0.50E	6.3E	10.1BC	57D
LSD @ 0.05	0.14	1.5	0.4	4

SS-LS2 is the susceptible check and Rhizosen is the tolerant check. Percent Rot was determined at harvest. The trial was planted February 23, 1990, and harvested August 28, 1990. Values are means of response of varieties to 0, 9 and 12 gallons per acre Telone II and 5 replications.

One of the trials was planted in January without prior notice so that only a single variety, SS-LS2, was planted in the plot. In February the second trial was planted to the previously mentioned varieties. The January trial was harvested October 10, 1990, and the February trial was harvested August 28, 1990,earlier

than planned due to an increasing incidence of root rot. The analysis and yield data for the February planted trial are presented in Tables 3 and 4. Table 5 summarizes data from the single variety fumigation trial.

TABLE 5. Sugarbeet Yield, Sugar Content and Percent Rot in Rhizomania Infested Soil using a Commercial Variety, SS-LS2, and Fumigating with Telone II

TREATMENT	TS/A	TB/A	% SUGAR	% ROT
Telone @9 gpa	1.51	16.8	8.9	32.6
Check	1.32	13.5	9.5	39.6
Telone @12 gpa	1.21	14.3	8.5	34.8
LSD @0.05	NS	NS	NS	NS
CV	40.0	30.4	16.3	53.4

Planted January 5, 1990, and harvested October 9, 1990. Values are means of 5 replications.

Two varieties were common to three of the fumigation/variety trials of 1989 and 1990, SS-LS2 and Rhizosen. A combined analysis comparing yields of these two varieties with 0, 9 or 12 gallons per acre of Telone II is summarized in Table 6 and 7.

TABLE 6. Significance Levels from the Combined Analysis of Variance for Three Fumigation/Variety Trials in 1989 and 1990

TRAIT	TREATMENT[1]	ENTRY[2]	TRT X ENT[3]
TS/A	**	NS	NS
TB/A	**	NS	NS
% S	NS	**	NS
% ROT	NS	NS	NS

** Significant at alpha = 0.01, NS = Not Significant

[1] Check, 9 and 12 gallons/acre Telone II (1,3-dichloropropene)
[2] SS-LS2 and Rhizosen
[3] Treatment x Entry Interaction

Fumigation has become a widely practiced means of insuring against major losses in rhizomania infested soils. In an attempt to quantify the effect of 1,3-dichloropropene on Polymyxa betae survival in the soil both trials in 1990 were sampled after fumigation, prior to planting. A total of 15 soil samples from each main plot (3 treatments, 0,9,12 gpa Telone II and 5 replications) were serially diluted and bioassayed for Polymyxa. Based on the results a most probable number of infection causing units was determined (Table 8). The wide variability in this data preclude drawing any definite conclusions relating to final yield results but does show an expected trend. Telone appears to reduce inoculum density but does not correlate with yield data. (r less than 0.20)

TABLE 7. Effect of Soil Fumigation and Sugarbeet Variety on Tons Sugar/Acre (TS/A), Tons Beets/Acre (TB/A), % Sucrose (%S) and Percent Rotted Beets (% ROT) under Rhizomania Conditions -- 1989, 1990

		TREATMENT			
	ENTRY	GALLONS/ACRE TELONE II			VARIETY
TRAIT	(VARIETY)	0	9	12	MEAN
TS/A	SS-LS2	1.39	2.18	2.09	1.88
	Rhizosen	1.48	1.84	1.90	1.74
	Treatment Mean	1.43	2.01	2.00	
	LSD @ 0.05	Var. x Fum.: NS		Var.: NS	Fum.: 0.18
TB/A	SS-LS2	10.7	16.0	15.6	14.1
	Rhizosen	12.4	14.9	15.3	14.2
	Treatment Mean	11.6	15.5	15.5	
	LSD @ 0.05	Var. x Fum.: NS		Var.: NS	Fum.: 1.18
% S	SS-LS2	12.9	13.0	12.8	12.9
	Rhizosen	13.1	13.4	13.2	13.2
	Treatment Mean	13.0	13.2	13.0	
	LSD @ 0.05	Var. x Fum.: NS		Var.: 0.18	Fum.: NS
% ROT	SS-LS2	26.1	20.3	20.7	22.3
	Rhizosen	21.4	19.3	21.1	20.6
	Treatment Mean	23.7	19.8	20.9	
	LSD @ 0.05	Var. x Fum.: NS		Var.: NS	Fum.: NS

SS-LS2 is a susceptible check and Rhizosen is a commercial rhizomania tolerant variety. Values are means of three trials over two years and 5 replications per trial. NS = Not Significant.

TABLE 8. The Influence of Post Fumigation Inoculum Levels on Tons Beets/Acre (TB/A) and % Sucrose (%S), of Sugarbeet Variety SS-LS2 under Rhizomania Conditions, 1990

TREATMENT GALLONS/ACRE TELONE II	TB/A	% S	INFECTION CAUSING UNITS/GRAM OF SOIL*
Check	13.5	9.5	313
Telone @ 9	16.8	8.9	16
Telone @ 12	14.3	8.5	87
LSD @ alpha = 0.05	NS	NS	NS
CV	30.4	16.3	152.5

*Polymyxa betae

Trial Planted January 5, 1990, and harvested October 10, 1990. Values are means of 5 replications.

SUMMARY

The wide variability in field trials over the past two years has made it difficult to draw many definite conclusions. The influence of curly top in 1989 and the major impact of unusually severe root rots in 1990 further complicated trial results. Growers continue to seek answers and only through field scale trials subjecting new rhizomania tolerant varieties to field conditions, i.e. other disease problems, will we find a combination of cultural practices, adapted varieties, and soil treatments that will work.

Tolerant hybrids continue to improve in yield in the South San Joaquin. Yields of SS-LS2 and Rhizosen without soil fumigation have remained fairly constant since 1988; Rhizosen yields are nearly twice those of SS-LS2. Newer varieties in 1990 show over a four fold increase in yields. Unfortunately, these yields are not at a level to allow the profitable production of sugarbeets under rhizomania conditions in the South San Joaquin

Valley. This becomes especially important now that Telone has been temporarily suspended from use.

The use of Telone II soil fumigation has shown a yield response of 3.9 tons of beets per acre over the past two years. In 1989 significant fumigant effects were found in contrast to no significant benefits in 1990. The extremely hot spring and summer of 1990 may have predisposed sugarbeets to enough root rot to mask any fumigant effect on rhizomania control.

It does seem clear that under the trial conditions, 9 gallons/acre of Telone II was as effective as 12 gallons/acre. Telone II did reduce inoculum of Polymyxa betae but not to a level that produced significant yield differences in 1990. It may be that fields selected in 1990, even when fumigated, sustained a level of Polymyxa above a threshold that causes disease. Alternatively, Polymyxa may have increased under the early warm spring conditions in 1990 fast enough to mask a fumigant effect. The other related possibility is that some of the heavier soils, such as those of 1990 cannot be fumigated effectively.

The trials of 1990 were set up as a best management approach to use all methods known to work or conjectured to work towards control of rhizomania. Fumigants were applied at an optimal soil moisture condition in the fall, perhaps risking reinfestation through the late fall and winter. Newer varieties adapted to the area having genes for tolerance to rhizomania were planted into cool soils nonconducive for Polymyxa development. All trial location fields had not been planted to sugarbeets for a normal three years.

This approach was used in the hopes of avoiding early rhizomania infection, serious curly top damage and to limit losses to high temperature pathogens. The final yields were a disappointment in most respects except for the performance of the varieties.

TABLE 1. Significance Levels from the Combined Analysis of Variance for Two Fumigation/Variety Trials in 1989

TRAIT	TREATMENT[1]	ENTRY[2]	TRT X ENT[3]
TS/A	**	**	**
TB/A	**	**	**
% S	**	**	**
% ROT	**	**	NS

** Significant at alpha = 0.01, NS = Not Significant

[1] Check, 9, and 12 Gallons/Acre Telone II (1,3-dichloropropene)
[2] R73H, R39H, SS-LS2 and Rhizosen
[3] Treatment x Entry Interaction

TABLE 2. Effect of Soil Fumigation and Sugarbeet Variety on Tons Sugar/Acre (TS/A), Tons Beets/Acre (TB/A), % Sucrose (%S) and Percent Rotted Beets (% ROT) under Rhizomania Conditions -- 1989

		TREATMENT			
	ENTRY	GALLONS/ACRE TELONE II			VARIETY
TRAIT	(VARIETY)	0	9	12	MEAN
TS/A	SS-LS2	1.91	3.11	2.95	2.70
	Rhizosen	1.66	2.16	2.28	2.03
	Treatment Mean	1.78	2.64	2.61	
	LSD @ 0.05	Var. x Fum.: 0.40		Var.: 0.17	Fum.: 0.21
TB/A	SS-LS2	13.8	21.4	20.4	18.5
	Rhizosen	11.8	14.9	15.7	14.1
	Treatment Mean	12.8	18.2	18.1	
	LSD @ 0.05	Var. x Fum.: 1.3		Var.: 0.6	Fum.: 0.7
%S	SS-LS2	14.1	14.6	14.5	14.4
	Rhizosen	14.4	14.8	14.7	14.6
	Treatment Mean	14.3	14.7	14.6	
	LSD @ 0.05	Var. x Fum.: 1.3		Var.: 0.1	Fum.: 0.1
% ROT	SS-LS2	5.1	2.0	1.6	2.9
	Rhizosen	6.5	3.4	4.0	4.6
	Treatment Mean	5.8	2.7	2.8	
	LSD @ 0.05	Var. x Fum.: 2.7		Var.: 1.1	Fum.: 1.4

SS-LS2 is a susceptible check and Rhizosen is a commercial rhizomania tolerant variety. Value are mean of two trials in 1989 and five replications per trial. NS = Not Significant.

Trials in 1989 and 1990 were split plot designs with main plots of 0, 9 and 12 gallons per acre Telone II (1, 3-dichloropropene) and rhizomania tolerant and susceptible varieties as subplots. Harvest was either in September or October and 0.023 acres (30 inch beds) of each subplot were weighed and two 25 lb. samples taken for tare lab analysis. Each trial had five replications. All fields had the normal sugarbeet rotation of a crop of sugarbeets every three to four years.

1989 TRIALS

The two trials in 1989 were nearly identical. Both were fumigated in late March and planted in April. The previous sugarbeet crop harvested in 1984 did not indicate rhizomania problems, averaging 37 tons of beets and 13.4% sugar. Both were in clay loam soils considered difficult to fumigate but not as difficult as the majority of soils in the area. Curly top was evident in July and was considered fairly serious based on visual observation of symptoms throughout the growing season.

Four varieties were tested in 1989. SS-LS2 and Rhizosen had been used in previous years as susceptible and tolerant checks, respectively. Two USDA entries into the trials, R73H and R39H, were tested as newer broad-based rhizomania tolerant varietal blends. The size of the plot dictated commercial hand thinning to leave a stand of approximately 35,000 seedlings per acre.

Each trial comprised 2.75 acres. Soil samples were taken randomly from both trials and analyzed using an ELISA bioassay. A total of 120 soil samples taken from each trial. One trial tested 30%, the other 80% positive for rhizomania. The distribution of the disease was fairly uniform throughout the trials. Yields were higher in the field with fewer positive samples but no conclusions were drawn relating yields and inoculum.

A combined analysis of the 1989 trials is presented in Table 1 and 2.