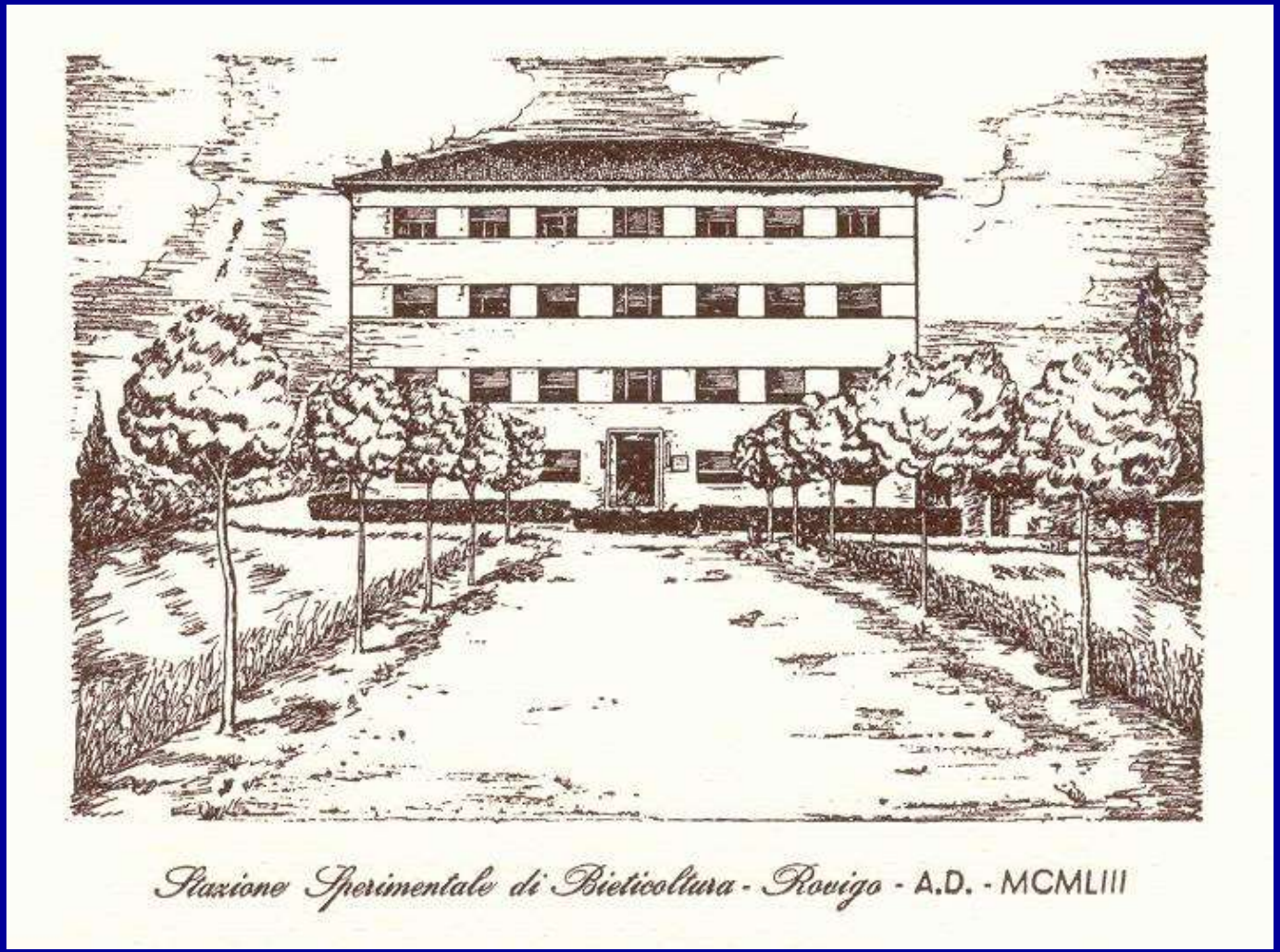
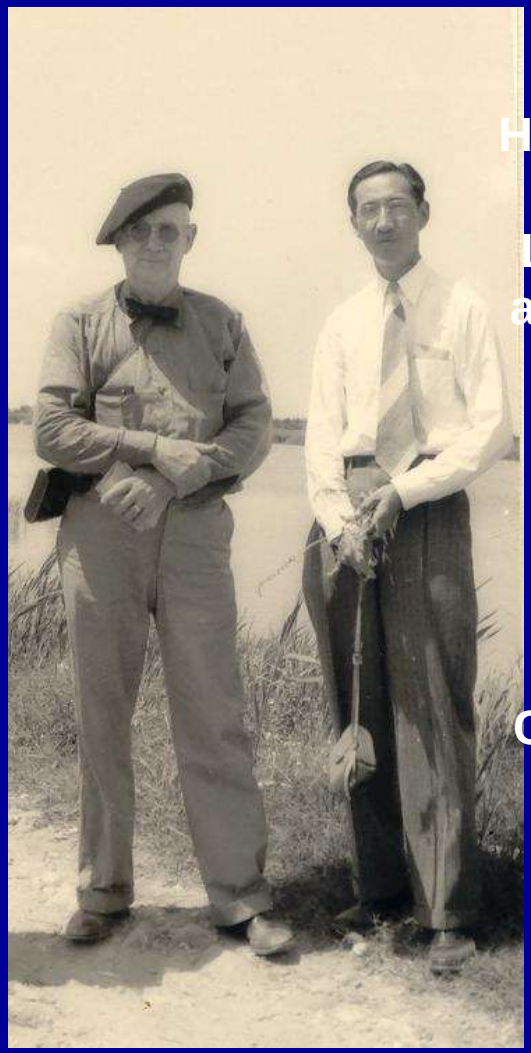
Stazione Sperimentale di Bieticoltura



Resistance to CLS and to rhizomania (Alba, Rizor) was derived from Porto Levante sea beets



Herbert G. Coons (USDA) and Lee Ling (FAO) at Porto Levante July 20, 1951

Coons visited the same locality in 1925, 1935 and 1960

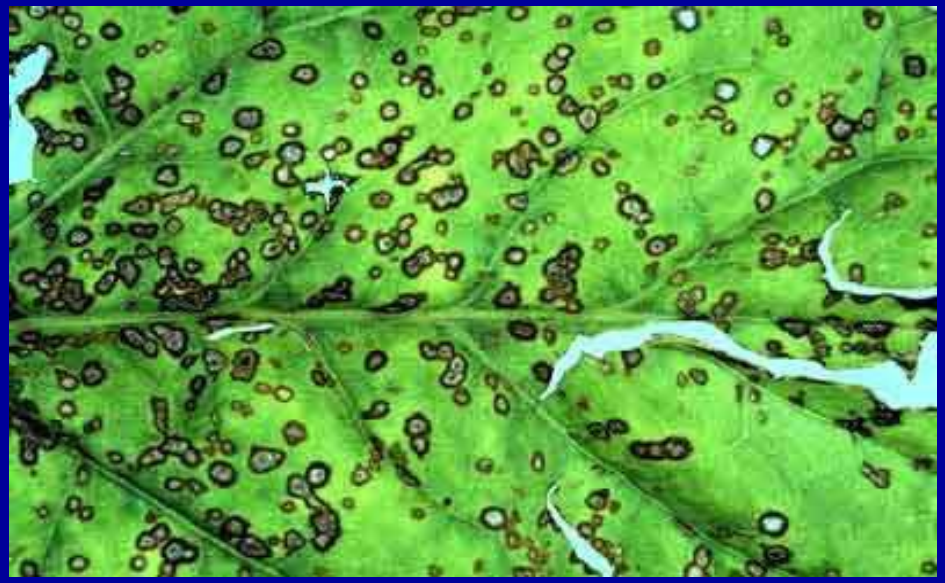
Abb. 12 Ganze kranke Pflanze (Stufe 5). Außenblätter sind abgestorben, Innenblätter mit schweren Schäden, stark einsetzender Blattneuaustrieb.
Fig. 12 Intera pianta malata (5° Stadio). Le foglie esterne sono morte; le foglie interne hanno subito gravi danni. Vi è un forte inizio di fogliazione.
Gr. 12 Plante entière, malade, (Stade 5). Les feuilles extérieures sont mortes, feuilles intérieures fortment endommagées, forte repousse de feuilles.
Picture 12 Whole plant diseased (step 5). Outher leaves are dead, inner leaves severely damaged, fresh foliage begins to grow.

Cercospora leaf spot

Resistance to cercospora leaf spot (CLS)

1909

First hybridation between sea beet and sugar beet



1925

First materials resistant to cercospora leaf spot

1935

First varieties resistant to CLS (R 581 line)

This material derived from crossings with the sea beet that Munerati selected at Rovigo (1925)

1937 - release of cercospora leaf spot resistant varieties (SB) in Italy and USA

G.H. Coons in the Po Delta

Brougth the CLS resistance in USA

Rhizomania - spread to the main sugar beet cultivated areas

- dramatically lowers sugar yield
- damage can be reduced only with the use of resistant varieties
- diseased areas are expanding

Rhizomania

Chronology of rhizomania

1946 - Abnormal expansion of "soil sickness" in Italy

1953 - First written reference

1954 - Beginning of systematic observations

1957 - The unknown syndrome was called "rizomania"

- Resistance in Italian varieties (Alba P)

1963 - Demonstration of the biotic origin of the disease

1966 - Discovery of the fungal-viral symbiosis

- Breeding activity on diseased fields

1984 - Release of Rizor (De Biaggi)

1986 - Release of Holly CMS lines (Erichsen)

1993 - New sources of resistance (Lewellen)

First reference on the unknown disorder

(from : Bollettino d'Informazioni dell'ANB, XIX, Oct. 10, 1953)

BOLLETTINO D'INFORMAZIONI DELLA A.N.B.

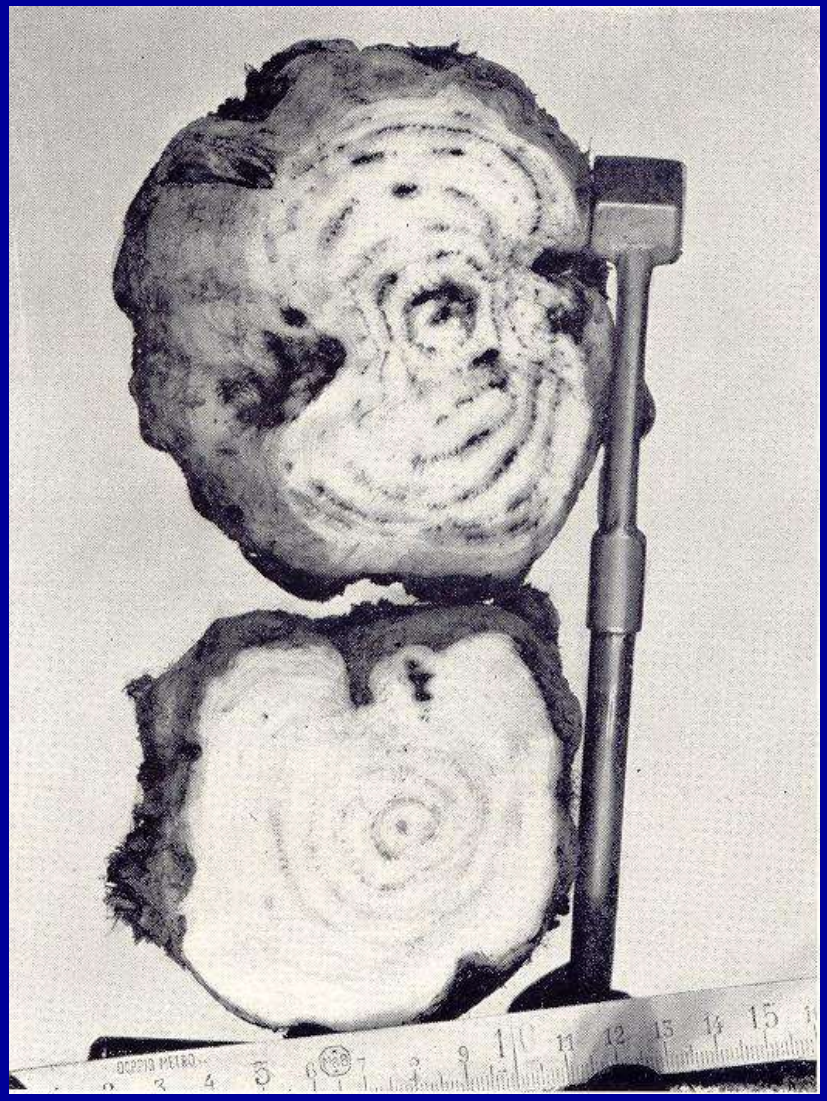
RADICI ECCEZIONALMENTE POVERE DI ZUCCHERO

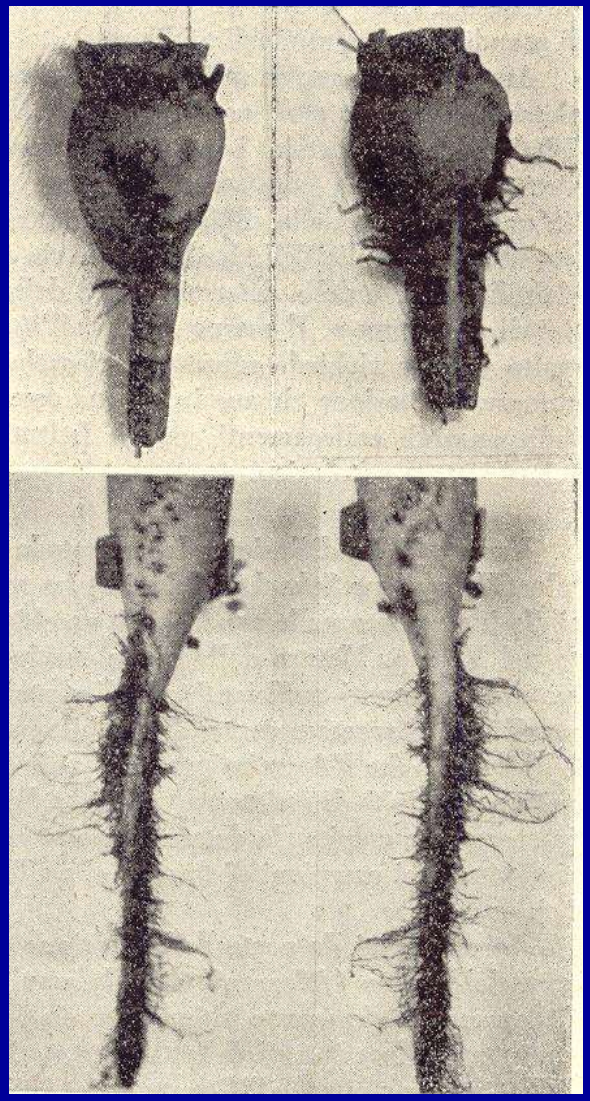
Un' indagine sulle colture a Cavarzere, Ceggia e Pontelongo

I lavori della commissione e i risultati delle ricerche. Le cause sono da ricercarsi nelle anormali vicende meteoriche dell'annata e nella attività della cercospora.

First illustrations of rhizomania symptoms

(from : Donà dalle Rose, 1957, 1958)





Diffusion of the unknown disease in soil

(from : Bongiovanni, 1964)

Inoculation of the plot

Bologna Oct. 11, 1962

Diseased beets on the plot

Bologna July 8, 1963

1957 variety trials in Italy on fields severely diseased the previous year

(from : Bongiovanni and Lanzoni, 1964)

Locality	Variety	Root yield (t / ha)	Sugar content (%)	Sugar yield (t / ha)
Cona (Venice)	Alba P	20.8	9.24	1.9
	Buszczynski CLR	16.8	9.98	1.7
Cavarzere (Venice)	Alba P	16.6	6.60	1.1
	Saros H 9 N (susc.)	7.4	5.06	0.4
Vighizzolo (Padua)	Alba P	17.0	8.12	1.4
	Mezzano NP	14.8	10.30	1.5

1983 yield evaluations in diseased fields

Locality	Rhizomania	Variety	Root yield (t / ha)	Sugar content (%)	Sugar yield (t / ha)
Erstein, France	severe	Rizor	45.1 a	17.80 a	8.0 a
		Monodoro	20.2 b	16.90 a	3.4 b
		Mono 1167	19.5 b	16.83 ab	3.3 b
		Mono 4086	22.7 b	17.42 a	4.0 b
		Ritmo	21.4 b	17.35 a	3.7 b
		Dora	14.7 d	15.52 bc	2.3 cd
		Monosvoløf (susc.)	6.0 e	12.35 d	0.7 e
S. Martino, Italy	severe	Rizor	49.7 a	15.93 a	7.9 a
		Ritmo	37.7 b	14.94 a	5.6 b
		Monodoro	41.1 b	13.46 b	5.5 b
		Monofort (susc.)	22.9 c	13.43 b	3.1 c
		Monova (susc.)	14.2 d	10.10 c	1.4 d

1985 yield evaluations in diseased fields at Salinas, CA

Rhizomania	Variety	Root yield (t / ha)	Sugar content (%)	Sugar yield (t / ha)
Moderate / severe	84C39 - 031	60.8	12.90	7.8
	Rizor	40.1	13.80	5.5
	Ritmo	31.5	12.80	4.5
	Monodoro	37.5	11.90	4.5
	Monohikari	25.5	12.20	3.2
	HH37 (susc.)	24.1	9.90	2.4
	USH 11 (susc.)	20.1	9.00	1.8
	LSD (P<0.05)	8.3	1.10	1.1

Performance of hybrids grown under moderate diseased pressure at Salinas, CA, in 2002

(Mean of two tests)

Variety	Rhizomania resistance	Root yield (t / ha)	Sugar content (%)	Sugar yield (t / ha)
Angelina	*Rz* , WB42	78.4	19.00	14.9
C 927 - 4H5	*Rz* , R22 *	80.2	18.10	14.5
Phoenix	*Rz*	81.1	17.60	14.4
Beta 4776 R	*Rz*	78.0	18.30	14.3
Rizor	*Rz*	70.8	18.70	13.3
USH 11 (susc.)	*rz rz*	53.3	15.60	8.4
LSD (P<0.05)		7.8	0.60	1.5

* R22 resistance from *B. vulgaris* subsp. *maritima* through population C50. (Lewellen, 1995)

1986 field trial at Salinas, CA

Susceptible check

WB42

1989 field trial at Salinas, CA

R22

Susceptible check

1995 field trials at Imperial Valley, CA

C67 and C72 (R22)

US H11 Rhizosen Rizor

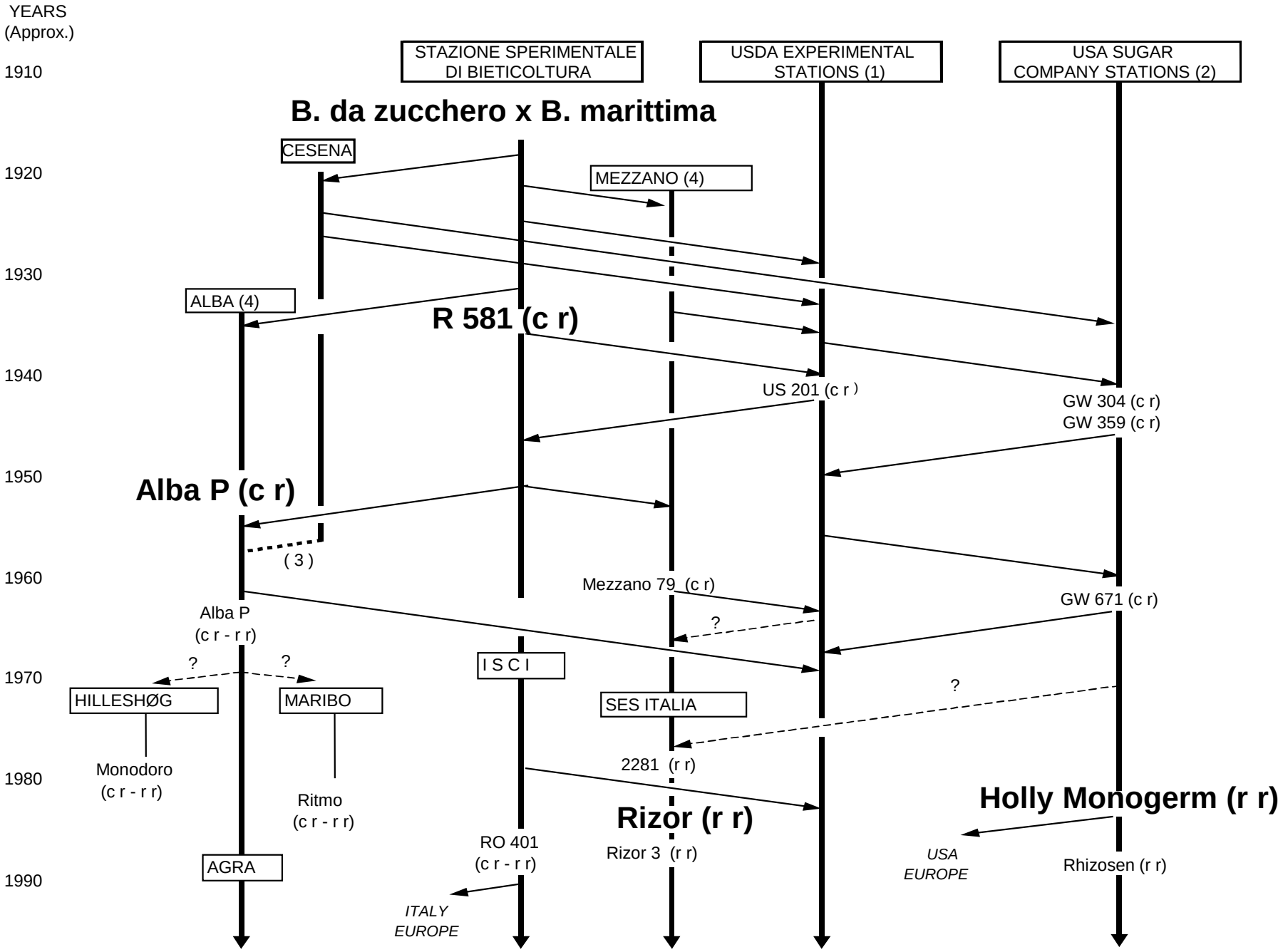
Origin of resistances to rhizomania

Alba ⟶ Munerati's CLS resistant germplasm ⟶ Sea beet

Rizor ⟶ Derived from CLS resistant germplasm ⟶ Sea beet

Holly ⟶ Unknown origin. Probably derived from sea beet

WB42 etc. ⟶ Sea beet


YEARS
(Approx.)
1910
1920
1930
1940
1950
1960
1970
1980
1990
STAZIONE SPERIMENTALE DI BIETICOLTURA
USDA EXPERIMENTAL STATIONS (1)
USA SUGAR COMPANY STATIONS (2)
B. da zucchero x B. marittima
CESENA
MEZZANO (4)
ALBA (4)
R 581 (c r)
US 201 (c r)
GW 304 (c r)
GW 359 (c r)
Alba P (c r)
(3)
Mezzano 79 (c r)
GW 671 (c r)
Alba P
(c r - r r)
?
?
?
?
I S C I
HILLESHØG
MARIBO
SES ITALIA
Monodoro
(c r - r r)
2281 (r r)
Ritmo
(c r - r r)
Holly Monogerm (r r)
Rizor (r r)
RO 401
(c r - r r)
Rizor 3 (r r)
AGRA
USA
EUROPE
Rhizosen (r r)
ITALY
EUROPE

Conclusions

Resistance to CLS and to rhizomania (Alba, Rizor) was derived from Porto Levante sea beets

The origin of rhizomania resistances appear to have a close relationship with sea beet

- This hypothesis is confirmed by molecular analysis