RELATIVE YIELD AND SALT TOLERANCE OF BARLEY AND OILSEED RADISH (RAPHANUS OLEIFERUS) [1.]

John R. Peters
Director, School of Agriculture
University of Saskatchewan

INTRODUCTION

Oilseed radish (Raphanus oleiferus) is one of about four cruciferous crops grown in Germany and possibly other parts of Northern Europe as either a green fodder or green manure crop following early harvested crops. Under relatively dry conditions it is planted in preference to rape, turnip rape or mustard because of its deep-growing and well-developed root system which may also result in soil melioration. Oilseed radish plowed down as a green manure crop has been shown to reduce the soil nematode population which are harmful to subsequent sugar beet crops (1).

In early 1981 information was received that oilseed radish had shown signs of considerable salt tolerance in tests conducted in Saskatchewan in 1980. In spite of the fact that frequently cited literature on crop tolerance to salinity (2, 3) does not include this crop and shows edible radish (Raphanus sativus) to be of low salt tolerance and because of the critical need to find alternative crops for the increasing area of salt-affected soils in Saskatchewan it was decided to test this crop for relative salt tolerance using Bonanza barley (Hordeum vulgare) as a comparison.

EXPERIMENTAL PROCEDURE

A farmer cooperator west of Rosthern known to have a field with a gradual and wide range of salinity levels agreed to include in a regular field of barley a four meter strip of Rauola oilseed radish. The field had been summerfallowed the previous year and was to be underseeded to sweetclover so that broadleaf weed control could not be undertaken and hence would not damage the radish. Seeding date was May 20, 1981. Both crops were fertilized with 11-51-0 at 56 kg ha^{-1} applied with the seed.

By July 27, 1981 the farmer was ready to cut the crops for silage (oilseed radish is not licensed for seed production in Canada and can be legally grown as a forage crop only). Accordingly, at this time paired samples of barley and radish each from an area one m^2 in size, were taken from ten sites approximately 30 meters apart starting from a spot where salinity was severe enough to reduce growth of both crops to almost zero.

---

1. Paper presented to the 1982 Soils and Crops Workshop, February 18-19, 1982, University of Saskatchewan.

Soil samples were taken directly between the two crop sampling areas at 0-15, 15-30 and 30-60 cm depths. Three cores were composited for each depth, the samples air-dried and analysed for salt content using the electrical conductivity of a paste extract method.

OBSERVATIONS, RESULTS AND CONCLUSIONS

Both crops were seeded under near excellent conditions. By July 9, 1981 the barley was starting to head out and the radish was flowering. There appeared to be some indication that the oilseed radish had not germinated as well as the barley but whether this was due to salinity or seeding method used could not be determined. Some flea beetle damage to the radish was noticed.

The relatively sparse population of radish plants did not appear to affect yield in that isolated plants invariably branched profusely so as to cover the entire area between plants.

At harvest time the barley was at the soft to medium dough stage and the radish was estimated to have completed 75% of its bloom. Pods had set well but were green and the seeds soft. It appeared that harvest could have been delayed somewhat which was later confirmed by the farmer cooperator who had found the silage of both the barley and radish slightly too high in moisture content.

The comparative yield data of the two crops is given in Table 1.

TABLE 1 Comparative Mean Green, Dry and Protein Yield of Barley and Oilseed Radish

Crop	Green Weight	Dry (105°C) Weight	Moisture Content	Protein Content*	Protein Yield
	kg ha^{-1}	kg ha^{-1}	%	%	kg ha^{-1}
Barley	8938	2850	69.1	12.8	364.8
Oilseed Radish	13264	1715	86.3	18.5	317.3
Difference	- 4326**	+1135**	-17.2**	- 5.7**	+ 47.5 NS

* % Protein or dry weight basis.
** Differences significant at $\leq$ 1%.

From the previous information it is quite obvious that the green weight yield advantage of oilseed radish relative to barley is due to its much higher moisture content. On a dry weight basis barley outyielded the oilseed radish by 1.135 tonne ha^{-1}. The high moisture content is also known to detract from its silage-making characteristics.

The protein level of the oilseed radish is slightly higher than the analyses of a sample submitted to the Saskatchewan Feed Testing Laboratory in March, 1981 which tested 15.68% but within the range of 18-20% suggested by the Prairie Seed Trust Company (1). The high mean protein level of material collected in this experiment is most likely due to the high soil nitrate levels associated with the saline conditions of the plot area. Previous experiments conducted on the plot area have shown a consistently high correlation between soil nitrate and salinity levels. The sample collected from the most saline site (10.9 mmhos cm^{-1}) was determined to have a protein content of 25.7%.

Although the protein content of the oilseed radish material was significantly higher than that of the barley the dry matter yield difference in favor of barley more than compensated for it. The 364.9 kg ha^{-1} of protein obtained by growing barley exceeded the 317.3 kg ha^{-1} obtained by growing oilseed radish by 47.5 kg ha^{-1}. This difference, however, was not statistically significant.

To test the relative salt tolerance of the two crops linear regression equations and correlation coefficients were determined relating mean soil salinity levels of the 0-60 cm depth to both dry and green weight yields. The results of these analyses are given in Table 2 and Figure 1.

TABLE 2 Linear Correlations Between Mean Soil Salinity Levels (0-60 cm) and Green and Dry Yields of Barley and Oilseed Radish

Crop	Correlation Coefficients	A-intercept Yield at Zero Salinity	Regression Slope	Yield reduction per unit increase in salinity	Soil Salinity at Zero Yield
	R-values	kg ha^{-1}	kg ha^{-1}	%	mmhos cm^{-1}
Green Barley	-.942**	16,045	-1180	7.35	13.6
Dry Barley	-.948**	5,314	- 409	7.70	13.0
Green Radish	-.940**	24,058	-1792	7.45	13.4
Dry Radish	-.932**	3,020	- 217	7.19	13.9

** Significant at $\leq$ 1%.

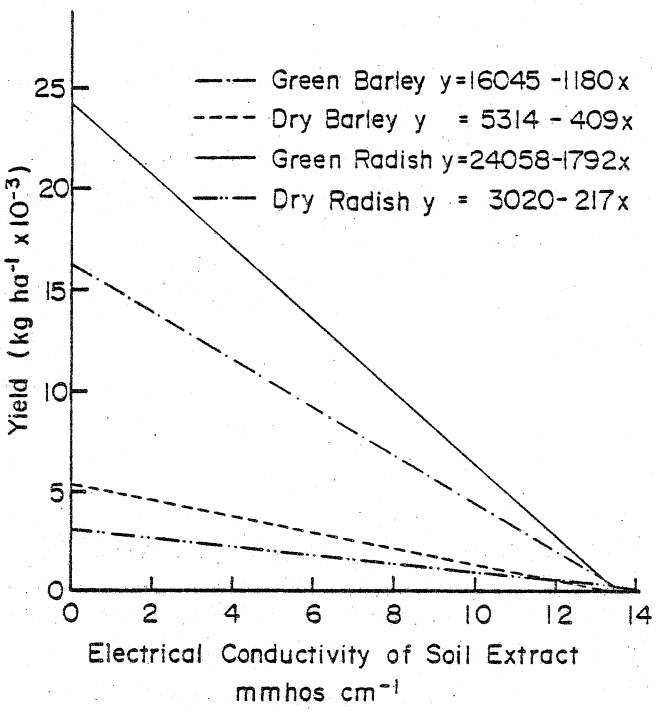

FIGURE 1 Linear regressions of barley and oilseed radish yield versus levels of soil salinity to a depth of 60 cm.

All four yield measurements were significantly correlated with mean soil salinity levels of the 0-60 cm depth. The relative salt tolerance of the two crops as measured by the yield reduction per unit increase in soil salinity, however, does not appear to differ significantly. The 7.35-7.70% yield reduction of barley per unit increase in soil salinity also compares quite favorably with estimates of 7.1% made by Maas and Hoffman (2). In addition the fact that all yield parameters lead to a zero yield at salinity levels between 13.0 and 13.9 mmhos cm^{-1} further supports the indication that there is little or no difference in the salt tolerance of these two crops when harvested for forage.

Another way of looking at relative salt tolerance is to combine site yields of common salinity ranges and compare the yield ratios of a given number of salinity groupings. Table 3 shows the results of such combinations.

TABLE 3 Mean Barley and Radish Yields According to Salinity Groupings (kg ha^{-1})

	Salinity Groupings (mmhos cm^{-1})			
	0-3	3-6	6-9.5	>9.5
Green Barley	15,410	9,935	4,643	4,675
Green Radish	22,787	16,470	7,853	3,890
B/R Ratio	.68	.60	.59	1.20
Dry Barley	5,086	3,195	1,395	1,334
Dry Radish	2,857	2,128	1,054	584
B/R Ratio	1.78	1.50	1.32	2.29
% Moisture				
Barley	67.0	68.4	69.9	71.8
Radish	87.5	87.1	86.4	83.7
Ave. EC	0.6	4.7	9.1	10.7
No. of sites	3	2	3	2

The barley/radish yield ratios calculated in this manner tend to indicate some greater salt tolerance of oilseed radish relative to barley up to a salinity level of 9 mmhos cm^{-1} after which there is a sharp change in favor of barley. The greater decline in the dry weight barley/radish ratio as compared to the green weight ratio from the non-saline (first) to the moderately saline (third) grouping appears to be primarily due to the fact that the moisture content of the barley increased with salinity whereas that of the oilseed radish decreased. However, due to the very limited number of sites in each group not too much emphasis can be placed on these results until further information is obtained. On the other hand since barley outyielded the oilseed radish and is perfectly acceptable as a forage crop one must question the merits of growing oilseed radish as a substitute.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance provided by Northern Sales of Saskatoon who provided the oilseed radish seed free of charge.

BIBLIOGRAPHY

1. Boehm, Juergen, Justus Liebig University, Giessen, West Germany. Material circulated to Saskatchewan farmers by Prairie Seed Trust Company in 1981.

2. Maas, E.V. and Hoffman, G.J., 1977. Crop Salt Tolerance-Current Assessment, Journal of Irrigation and Drainage, Vol. 103, No. 2, pp. 115-134.

3. Richard, L.A., Editor, 1954. Diagnosis and Improvement of Saline and Alkali Soils, Agriculture Handbook, No. 6, U.S.D.A.