CROP YIELD AND SOIL SALINITY IN FARMERS' FIELDS; DATA FROM EGYPT, INDIA, AND PAKISTAN, USED TO FIND SALT TOLERANCE LEVELS OF CROPS
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The soil salinity is expressed in electric conductivity of an extract of a saturated paste (ECe) of a soil sample in dS/m (millimho/cm).

Introduction

For a comparison of the outcomes of the salt tolerance of crops in this article with data found elsewhere, the generally used classification worldwide is given in the following table (Richards, 1954, Saline and Alkali Soils, USDA Handbook 60).

ECe (dS/m)	Class	Effect
0-2	Non saline	Negligible
2-4	Slightly saline	Yield reduction of very sensitive crops
4-8	Moderately saline	Yield reduction of many crops
8-16	Strongly saline	Satisfactory yields only for salt tolerant crops
>16	Very strongly saline	Satisfactory yield for a few very tolerant crops only

Interpretations:

Crops with a tolerance level of ECe = 4-6 dS/m (i.e. the level at which the yield starts to decline is between 4 and 6) may called *(slightly) sensitive* crops.

Crops with a tolerance level of ECe = 6-8 dS/m may be called *moderately salt tolerant* crops.

A tolerant crop (with tolerance level in group 8-16) is more than moderately tolerant, and we can say: *"quite tolerant"*.

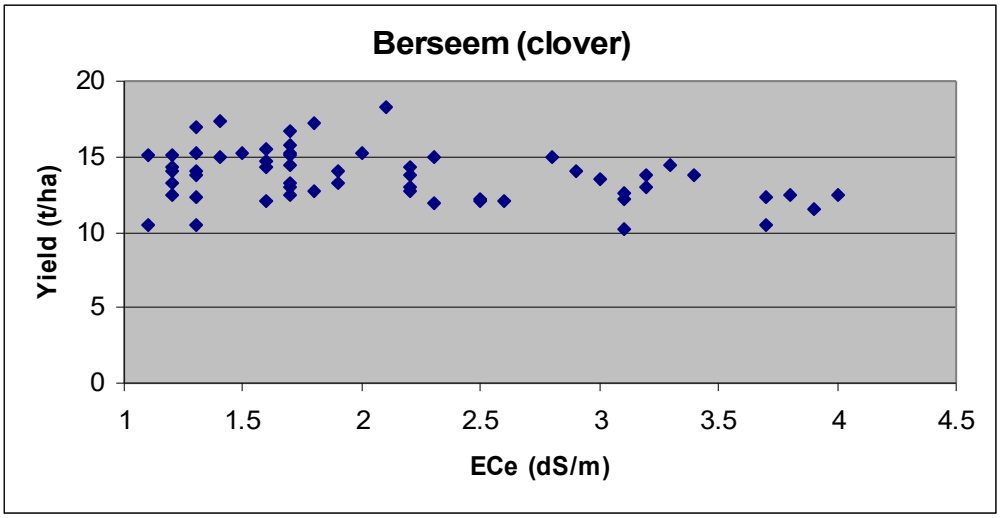
When the yield already starts declining when the salinity is less than 2 dS/m, then the crop can be called *hyper sensitive*.

I - EGYPT

Data from: H.J. Nijland and S. El Guindy, *Crop yields, watertable depth and soil salinity in the Nile Delta, Egypt*. IN: Annual report 1983. International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands.

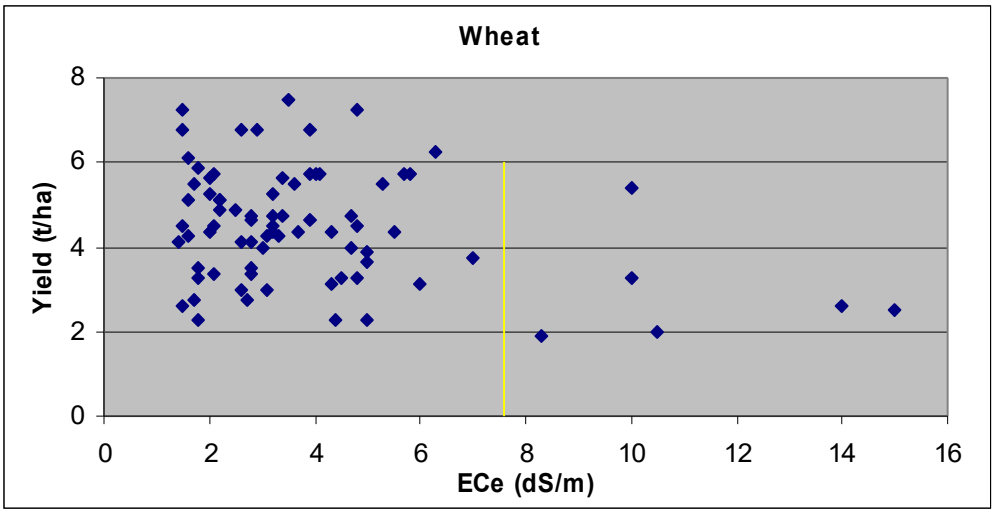
Crops are: berseem (clover), wheat, rice, maize and cotton.

A – Berseem



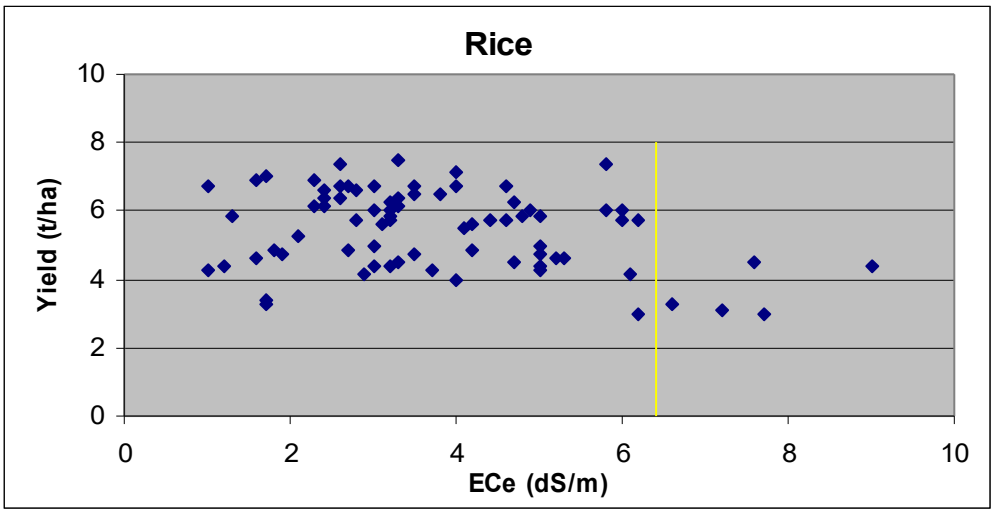
Berseem (Egyptian clover) data were collected from 4 cuts in the winter season 1979-1980 in the villages Minyet Beni Mansur, Darawa, Mit Loza and Nizaret Fisha Balkha. The yield represents fresh green matter. ECe represents the average soil salinity over the season.
As the salinity in the region is not very high, no data are available on the yield decrease at higher ECe values. The salt tolerance of Berseem is at least 4 dS/m because the trendline through the data is (almost) horizontal (a plateau). All yields are above 10 t/ha. A sharply declining trend cannot be seen.

B – Wheat



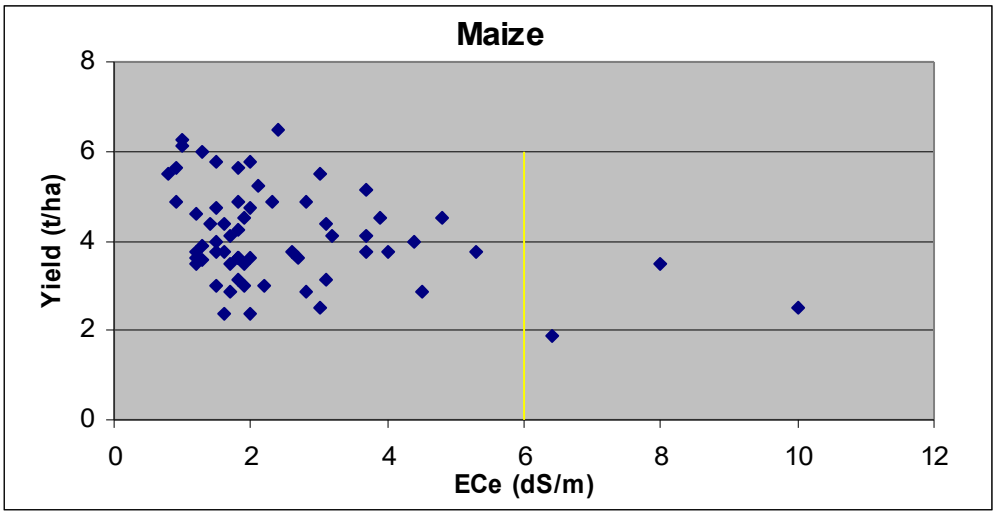
The grain yield of wheat was collected in the winter season 1981-1982 in the villages Mit Loza, Kafr Shubra Qallug and Nizaret Fisha Balkha. Like for Berseem, the number of data with high soil salinity (> 12 dS/m) is scarce so that the salt tolerance of wheat cannot be precisely determined. The figure suggests that the salt tolerance of wheat is at least 7 or 8 dS/m because up to that point there is no significantly descending trend. Wheat appears to be a more than moderately tolerant crop.

C - Rice



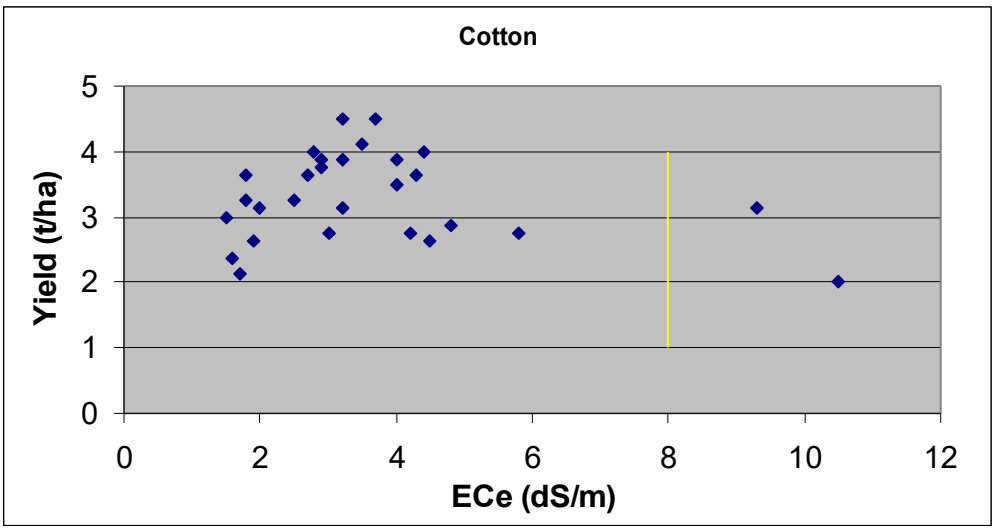
The rice is of the short grain (Japonica) type. Rice nurseries are prepared in May and transplantation occurs in June. Harvest is in October. The grain yields were collected in 1981 and 1982 in the village Mit Loza. As the number of data with ECe > 7 dS/m is small, the salt tolerance of rice cannot be exactly found, but it is at least 6 dS/m. Up to that point the trendline is slightly, but insignicantly, sloping upward. Rice is certainly a moderately tolerant crop, if not more than that.

D – Maize (Corn)



Maize is planted in the First half of June and harvested from mid September to mid October. The grain yield of Maize was determined in 1981 in the villages Kafr Shubra, Darawa and Minyet Tukh. There are few data with ECe > 6 dS/m, but from the figure it can be deduced that the salt tolerance of maize is 6 dS/m or higher. Maize is a moderately tolerant crop and maybe more than that.

E – Cotton



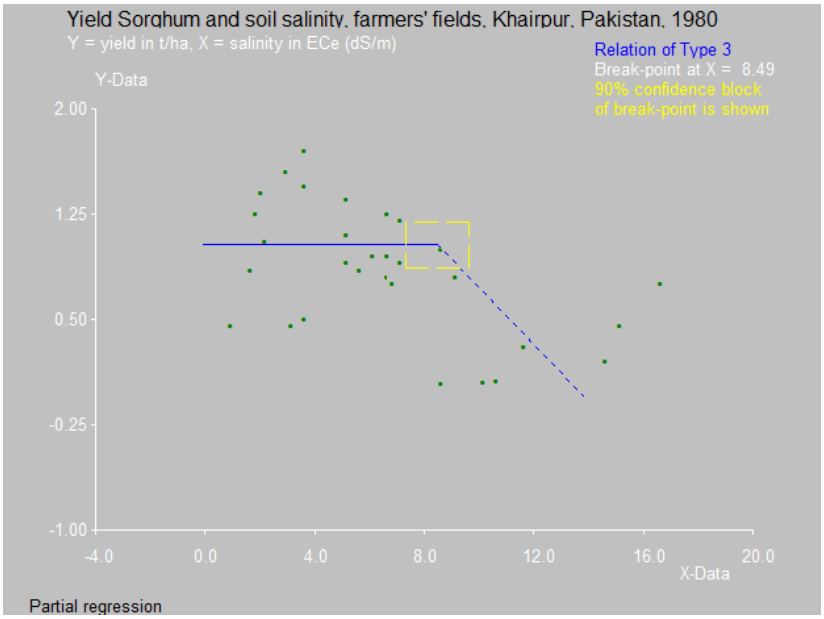
The cotton yield (lint+seed) was determined in the summer of 1981 in the villages Minyet Tujh, Darawa, Mit Loza and Kafr Shubra Qallug. Again, there are not many data with ECe > 8 dS/m. The salt tolerance of cotton is possibly greater than 8 dS/m. Cotton is definitely a more than moderately tolerant crop.

3 – PAKISTAN

Data from: R.J. Oosterbaan, *Crop yields, soil salinity and water table depth in Pakistan*.
In: Annual Report 1981, p. 50-54. ILRI, Wageningen, The Netherlands.
Reprinted in Indus 24 (1983) 2, p. 29 - 33.

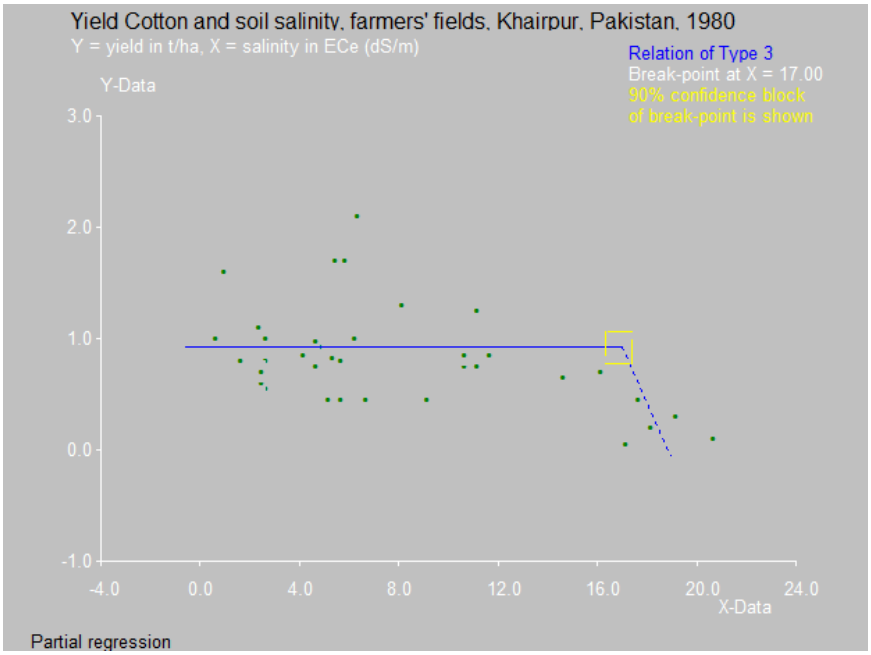
The data were collected in the framework of the Pakistan-Netherlands cooperation in the Drainage Institute of Pakistan (DRIP), Hyderabad. The collection of the data occurred in small plots (several m^2) selected at random in farmers' fields.

A- Sorghum



The yield of sorghum is not negatively affected by soil salinity up to a level of ECe=8.5 dS/m (the plateau). Beyond that point a sharp yield decline occurs with increasing ECe values. According to the generally accepted classification, this sorghum is a salt tolerant and may even be called "quite tolerant".

B - Cotton



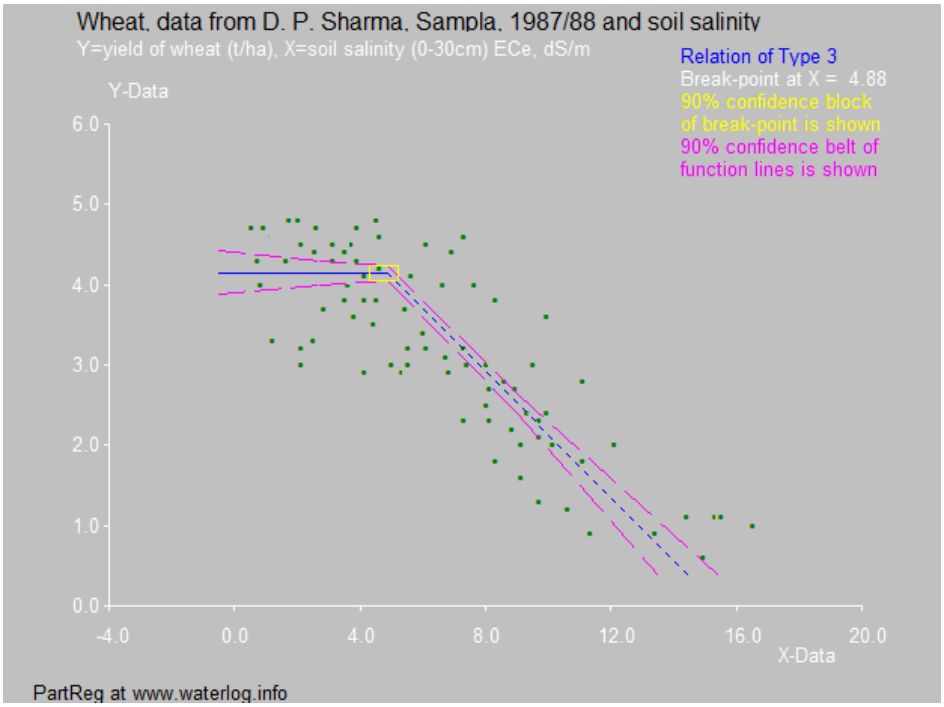
Up to ECe=17 no significant yield decline can be detected (the plateau). Thereafter a sharply declining trend manifests itself. Doubt may arise as to the robustness of the breakpoint on grounds of the limited number of data with an ECe value greater than 14. However, the statement that the tolerance level is higher than 12 will probably not meet with much resistance. This cotton crop, according to the widely accepted classification, is quite tolerant to very tolerant to soil salinity.

C – INDIA

The data were collected in the framework of the Indo/Dutch Network Operational Research Project (IDNORP) on Irrigation, Drainage and Land Reclamation. The collection occurred in small plots of several m2, randomly selected in farmers' fields.

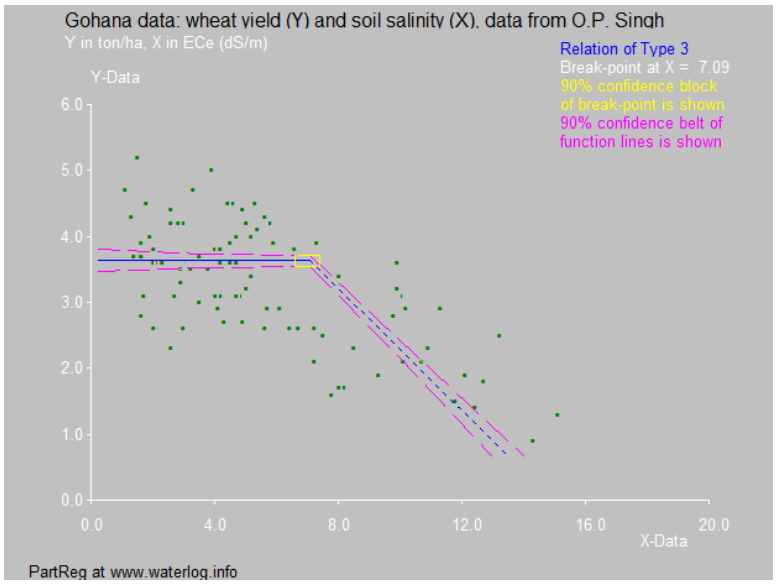
A – Wheat

A1 – Wheat in the Sampla area, Haryana, data from D.P. Sharma (personal communication)



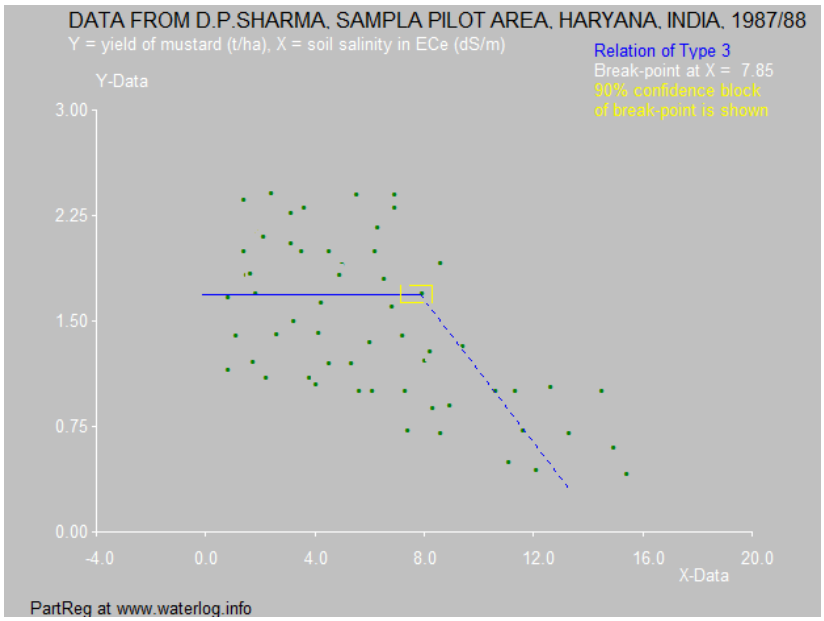
In contrast to the previous examples, here there were enough data with ECe beyond the tolerance threshold to be able to detect precisely where the initially horizontal trend (the plateau) in the relation between yield and salinity changes into a downward trend. The maximum salt tolerance of wheat in Sampla is 4.9 (say 5) dS/m before it starts to be affected negatively when the ECe increases more. This wheat crop is slightly sensitive to salt.

A2 – Wheat in the Gohana area, Haryana, data from O.P. Singh (personal communication)



The wheat data of Gohana show a higher salt tolerance (ECe=7dS/m) than the Sampla data. The reason is unknown. The average yield below the breakpoint is somewhat less, and the variation of the yield is higher. The slope of the regression line through the data below the breakpoint (the plateau) is very small and insignificant, so it might be concluded that there is no effect of salinity on the yield up to this point. However, owing to the high variation, it might be argued that the tolerance threshold could be 6 instead of 7 dS/m. Anyway, the wheat in Gohana can be called salt tolerant.

B – Mustard (rapeseed)

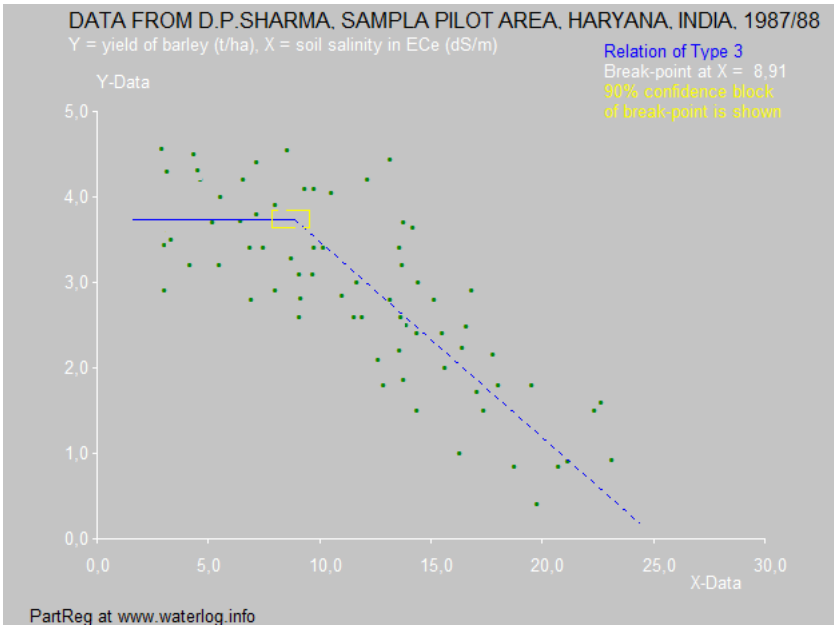


It is a characteristic of most field data collected in small plots on the yield – salinity relation that they show considerable scatter. Mustard is no exception. Yet, the salt tolerance of mustard in the above graph shows consistently and systematically lower yields at ECe levels

greater than 8 compared to the yields at lower ECe levels. In this example there is a pronounced discontinuity, a sudden jump, in yields to the left (the plateau) and to the right of the threshold. So it can be safely concluded that mustard is “quite tolerant”.

C – Barley

Barley, like cotton, is generally known as a salt tolerant crop. The following figure confirms this property with a threshold value of 8.9 (say 9), which proves that this crop is “quite tolerant”. This barley is apparently grown in saline lands as there are many observations in the range of ECe = 10 to 25 dS/m. The random selection of plots proves that the average salinity is greater than that at the breakpoint. It seems that farmers accept a somewhat lower yield, probably because there is no alternative land use and the barley still provides them with some income.



CONCLUSION

All data shown of crops cultivated in the subtropics in farmers’ fields manifest considerable salt tolerance and their tolerance level could be determined quite accurately despite the large yield variation owing to a fair number of samples permitting to fix the general yield-salinity relation according to the so called Maas-Hofman model.

Farmers in saline irrigated lands manage to develop salt tolerant crops.