BREEDING FOR BORON TOLERANCE AND ITS IMPACT ON YIELD COMPONENTS OF BARLEY VARIETIES

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ABSTRACT: Boron toxicity is considered a problem in the Central Anatolia as well as semiarid areas in the world. For this reason, barley *(Hordeum vulgare)* breeding material supplied from CRIFC and AARIs' barley breeding programs was tested for three years on inherently B toxic fields in order to find out genotype tolerance to toxicity.

There was a great variation within the material tested for boron toxicity and a number of entries was more tolerant than tolerant check variety, Anadolu-86. Seed yields, total biomass, and harvest indexes were reduced but 1000 kernel weight was not affected as the toxicity symptoms on plants intensified.

As a conclusion, current barley breeding material has possessed enough sources of tolerance to B toxicity problems because of negative selection against toxicity and use of Turkish barley landraces in the crossing program.

BOR FAZLALIĞININ ARPA ÇEŞİTLERİNİN VERİMLERİNE ETKİSİ VE BORA KARŞI DAYANIKLILIĞIN GELİŞTİRİLMESİ

ÖZET: *Dünyanın birçok yarı kurak alanlarında olduğu gibi Orta Anadolu'da da bor fazlalığı bir sorun olarak kabul edilmektedir. Bu nedenle, TARM ve ATAE 'nin arpa ıslahı programlarından sağlanan arpa ıslahı materyali üç yıl boyunca borla bulaşık alanlarda denendi.*

Bor fazlalığına karşı test edilen materyal arasında hem geniş bir varyasyon hem de araştırmada kullanılan toleranslı çeşit Anadolu-86 dan daha iyi hatlar saptandı. Bitkilerde gözlenen bor fazlalığı belirtilerinden dolayı hasat indeksi, biyolojik verim ve tohum veriminde azalma olurken 1000 tane ağılığında herhangi bir olumsuzluk gözlenmemiştir.

Sonuç olarak Türkiye'nin farklı yörelerinden toplanan köy çeşitlerinin melezleme programlarında kullanılması ve bor fazlalığına duyarlı genotiplerin elenmesinden mevcut arpa genetik materyalinin bor fazlalığına karşı yeterli olduğu sonucuna varılabilir.

INTRODUCTION

Boron toxicity problem together with zinc deficiency was reported as the most important micro-nutrient problems in the Central Anatolian Plateau (Sillanpaa, 1982). Kalaycı et al.(1996) investigated B toxicity on bread and durum wheat cultivars in greenhouse and field conditions and concluded that durum cultivars were more susceptible than bread wheat cultivars and symptom scoring was more reliable in assessing tolerance than shoot or root B concentrations.

In the Central Anatolian Plateau, barley improvement program has so far mainly focused on drought and winter hardiness with only a limited consideration to micro nutrient effects. The boron toxicity in barley which is more susceptible to micro nutrient problems than bread wheat has also been considered a problem in certain parts of the plateau. Thus, a

project was launched in order to (i) assess the importance of boron toxicity in Central Anatolian Plateau, (ii) identify and develop barley varieties capable of growing in high boron soils.

This paper deals partly with the second objective of the results of the project and some other activities carried on B toxicity for the Central Anatolia. With respect to first objective, the early results revealed that B toxicity in the Central Anatolia was not a serious, extensive problem. lt confined to small and isolated areas which are not large enough for any economical consideration.

MATERIALS AND METHODS

The barley material provided from the main research institutions working in the Central Anatolia was used in this study. Experiments carried out in the fields which have inherently toxic soil containing 5 to 30 ppm boron, between 5 to 15 ppm in Ankara and between 15 to 30 ppm in Eskişehir. Cvs. Hamidiye and Anadolu-86 used as checks were tolerant and susceptible to excess boron in the soil, respectively.

The entries of lines (168 in 1994-95; 170 in 1995-96; 72 in 1996-97) and checks were planted in 2 rows with 2 meter-long, employing RCB design with 3 to 4 replications. The leaf symptoms on the plants resulted from B toxicity were observed and quantified using 0 (no visible symptoms) to 5 (visible symptoms on whole plant) scale. Experiments were conducted during 1994-95 to 1996-97 growing seasons at originally boron toxic fields of Hamidiye, Eskişehir and Kazan, Ankara locations. In the last year (1997) of research, one set of the material was also sown towards the end of winter (March, 11).

RESULTS AND DISCUSSIONS

During experimental years, all entries in all experiments showed strong responses to boron toxicity and statistically significant impact on yield and leaf symptoms were observed (Tables 1 and 2).

Table 1. Some of statistical parameters of ANOVA tables for barley yields on inherently B toxic soils

	DF	1994/95	DF	1995/96	DF	1996/97
Replications	2	P<0.01	2	P>0.01	3	P>0.01
Entries	167	P<0.01	169	P<0.01	71	P<0.01
CV %		22.20		18.00		13.20

Table 2. Summary of ANOVA for the toxicity scores of entries on inherently B toxic soils in Turkey's dryland areas.

	DF	1994/95	DF	1995/96	DF	1996/97
Replications	2	P>0.01	2	P>0.01	3	P<0.01
Entries	167	P<0.01	169	P>0.01	71	P<0.01
CV %		14.80		15.60		23.90

Toxicity scores for the entries obtained from all experiments were negatively correlated with the seed yields (Figure 1)

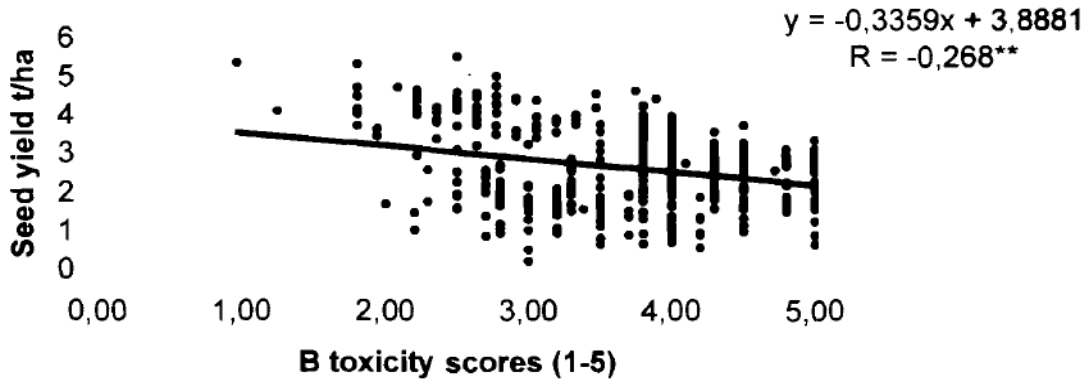

Figure 1. Seed yield and B toxicity scores relationships for barley in different years in dryland plateau of Turkey.

The experimental results of different years were summarized as graphics in Figure 2. Iin 1995, only two entries were better than cv.Anadolu-86 in terms of leaf damage scores. Yield performance of cv.Cyclone, Lignee-527, Star, Victoria, Steptoe, Plaisant, Monolit and Precoce all of which were introduction material used as check making comparision between domestic and exotic material was very low and having poor to medium scores of toxicity. Some of the Turkish varieties performed better than the tolerant check in terms of tolerance to B toxicity and yield. Most of the entries ranged between 2.6 to 4.0 levels of toxicity. This result shows that use of landraces in breeding program can contribute not only as adaptive material to main stress factors but also to micro nutrients toxicity such as boron.

1996 results indicated that numerous entries tolerated to toxic soil B better than cv. Anadolu-86. On the other hand, the number of susceptible entries also increased. Of the tolerant entries, six were outstanding with respect to leaf damage scores. Moreover, they also had seed yields at least equal to one or more than the tolerant check.

In 1997, materials were tested in separate toxic fields. There were a few very good tolerant entries and many more lines better than cv. Anadolu 86 in one set of material provided from Anadolu Agricultural Researh Institute. No entries, however, was detected

having similar response to that of cv. Hamidiye susceptible check. The second set of material provided from CRIFC barley breeding program had many lines showing better tolerance than the tolerant check whereas the number of susceptible lines were relatively low (Figure 2).

The relationships between harvest index (%), seed yield and total biological yield and thousand kernel weight illustrated in the Figure 3 measured in the last experimental year. Seed, biological yield and harvest indexes were negatively correlated with the boron toxicity levels and were significant at $P<0.01$. Mostly the susceptible check, Hamidiye, didn't provide seed yield because of toxicity and the late

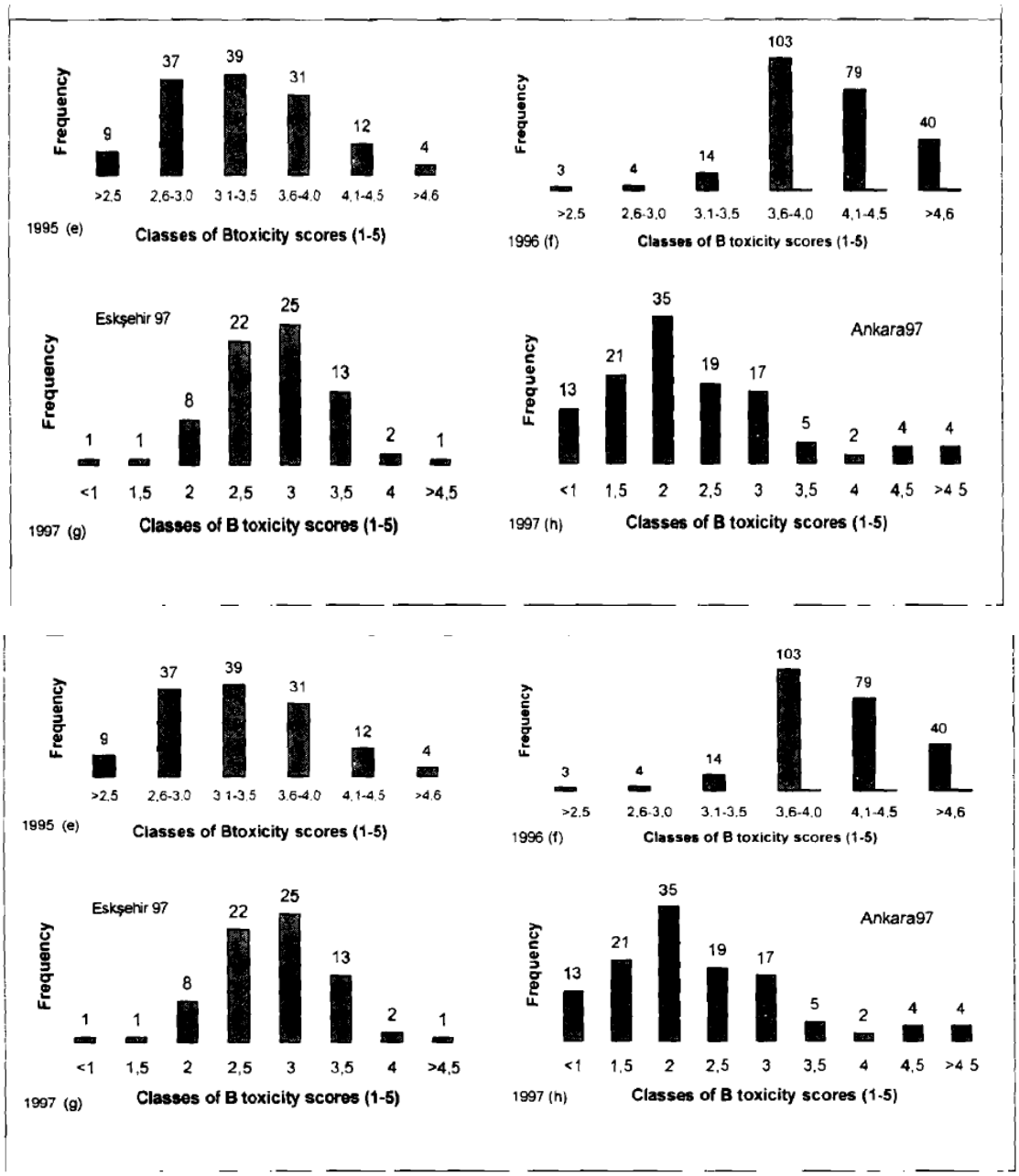

Figure 2. B toxicity scores and seed yields as compare to check varieties (a to d) and frequency distribution of genotypes over toxicity scores (e to h).

seeding, but at the same time it had reasonably high biological yield. Kernel weight was not correlated (r=0.00001) with the toxicity scores. This might be due to excluding some entries, which they were unable to produce heads, from the correlation analysis.

In terms of all characteristic measured and observed, responses of entries due to B stress might be grouped into four: (i) having low yield and high leaf toxicity (susceptible); (ii)low yield low leaf toxicity (intermadiate) (iii) high yield and low leaf toxicity (tolerant) (iii) high yield and high leaf toxicity. The last group was called as "specific tolerance" (Cartwright et all, 1987). Some of the lines including cv.Bülbül-89 variety demonstrated this type of tolerance.

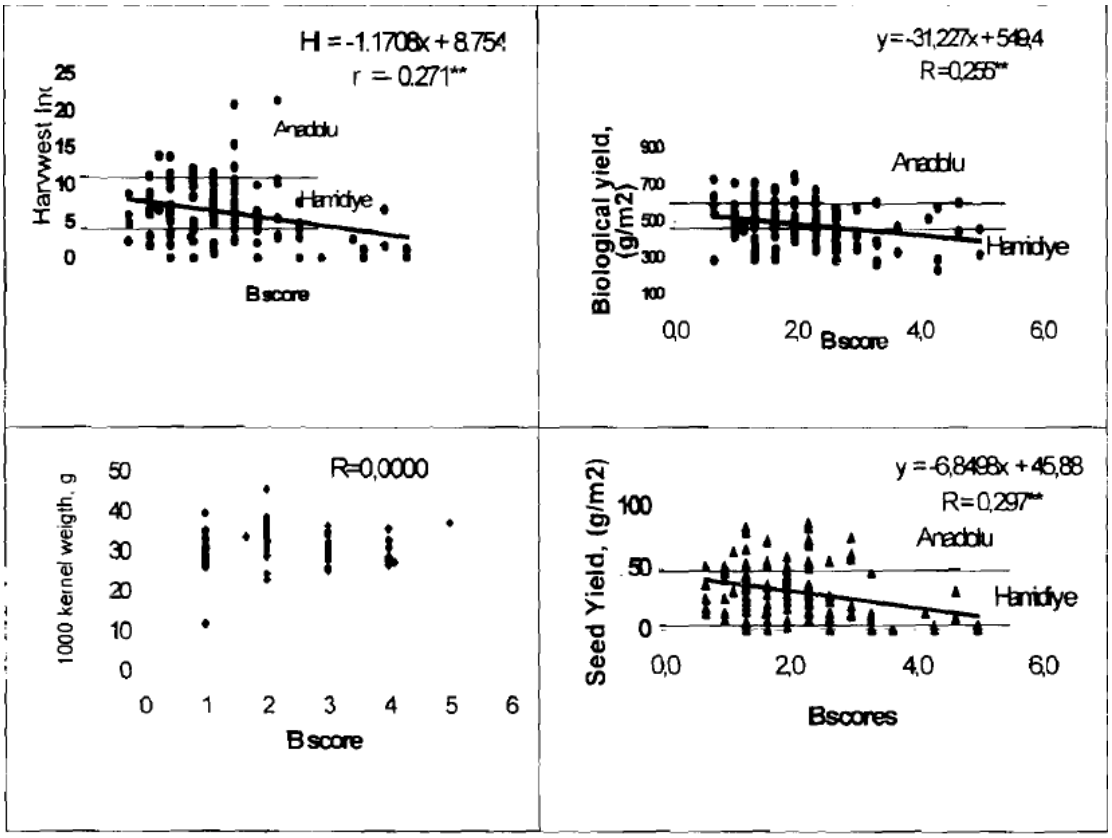

Figure3. Relations of toxicity on plant leaves and harvest indexes (HI, %) and biological yields (BY) and seed yields with references to susceptible and tolerant checks.

CONCLUSIONS

Breeding material has possessed relatively wide variability in terms of B toxicity. Because of indirect selection made to boron toxicity, there was no line more susceptible than Hamidiye whereas there were more tolerant lines than Anadolu 86 in the Turkish barley germplasm. This implied that the barley breeding program was on the safe line with respect to B toxicity related problems.

Seed yields of all entries were reduced as the degree of the toxic damages on the leaves increased. B toxicity also lowered total biomass, and harvest indexes of the entries. Despite of negative effect of boron toxicity on yield and the yield components, some lines and genotypes maintained high seed yield level such as cv.Bülbül -89, so specific tolerant

lines with sound yield potential should be given enough importance by barley breeders working on rainfed areas.

The progeny of the same crosses showed varying responses to the toxic soil B from susceptibility to semi-tolerance, therefore it provides big opportunity to be selected high yielding cultivars having boron tolerance.

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