HELIA, **25**, Nr. 37, p.p. 51-58, (2002) UDC 633.854.78:631.416:54-38

EFFECT OF SODIUM CHLORIDE ON SUNFLOWER (*Helianthus annuus* L.) SEED GERMINATION

El Midaoui Mohammed[1], Mohamed Benbella[1] and Ahmed Talouizete[2]

[1]*Département d'Agronomie et d'Amélioration des Plantes, Ecole Nationale d'Agriculture, BP S/40 Meknès, Marocco*
[2]*Département de Biologie, Faculté des Sciences Sidi Mohammed Ben Abdellah Dhar El Mahraz Fès, Marocco*

Received: January 27, 2001
Accepted: October 15, 2002

SUMMARY

Seed of three sunflower genotypes (Oro9, Flamme and Albena) were germinated in petri dishes placed in an incubator maintained at 28°C. Six NaCl concentrations (0, 50, 75, 100, 125 and 175 mM) were used to moisten seeds. Results showed a decline in seed germination of the three genotypes as NaCl concentration was increased in the medium. After six days of incubation, significant differences were observed between control and treatments. Mean comparison of treatments did not reveal a significant differences neither between 50 mM and 75 mM treatments nor between 100 mM and 175 mM. Among the genotypes, Flamme was most sensitive. Average time of seed germination was significantly affected by both NaCl concentration and genotype.

Key words: ***Helianthus annuus* L., sodium chloride, percent germination, average time of seed germination**

INTRODUCTION

Salinity is one of the main factors that induce in many areas of the world, especially in arid and semi arid area, a significant decrease in crop yields (Srivastava and Jana, 1984). Salt water was used by many investigators to study tolerance or sensitivity of many crops to salinity. Compared with other crops, sunflower is considered as a slightly tolerant crop (Maas and Hoffman, 1977; Hardwick and Ferguson, 1978; Helka *et al.*, 1980; Blamey *et al.*, 1986; Katerji *et al.*, 2000).

Negative effect of salinity on grain yield reported by many workers (Abel and Mackenzie, 1964; Katerji *et al.*, 1996; Vulkan-Levy *et al.*, 1998; Katerji *et al.*, 2000), prompted investigations on relationships between tests at early stages of growth and grain yield. Studies were carried out on several species for which interest was given to relationships between seed germination or seedling growth under salt stress conditions and grain yield. Reported results were characterized by discrepancies. Jana and Slinkard (1979) found a close relationship between the rank

of lentil lines, based on germination and vegetative growth under salt stress and rank of the same lines grown under field conditions. Katerji *et al*. (1994) found also a close relationship between percent reduction of growth of salt stressed sunflower and corn and their grain yield under controlled conditions. In addition, Shaller *et al*. (1981) reported that seed germination test allowed to rank barley genotypes in the same order as their salt tolerance. On the other hand, Ashraf and Waheed (1990) did not find any relationship, for barely, between salt tolerance tests at germination and the ones measured at seedling stage. Gill and Duut (1982), as well as Srivastava and Jana (1984) reported the same results for several cereals. Shaller *et al*. (1981) consider that results of germination test might be a good indicator of salt tolerance. Discrepancies might be partly explained by the lack of compensation phenomena between plant density and the other component in crops such as sunflower or corn. For these crops optimal plant density is a prerequisite for a good yield. Therefore, factors that might limit this component will have a direct effect on grain yield. Good conditions for seed germination is necessary for a good establishment of sunflower. In Marocco, sunflower has began to be produced in irrigated area. A relatively high soluble salt concentration of water used to irrigate sunflower in these areas might have a negative effect on seed germination and then on plant population, crop growth and hence on grain yield. Under these conditions, a search for salt tolerant sunflower genotypes is a way to alleviate effects of saline water on germination, growth and grain yield of this crop. The purpose of this work was to study the effect of several NaCl concentration on seed germination of three sunflower genotypes.

MATERIALS AND METHODS

Three sunflower genotypes (two hybrids: Flamme and Albena and a variety population: Oro9) were germinated under five NaCl concentrations and a control (distilled water). Twenty-five seeds of each genotype were put to germinate in a petri dish between two sheets of filter paper (Watman n°1). Seeds were humidified with 5 ml of saline solution and put in an incubator maintained at 28°C in a randomized complete design with three replicates. Counting of germinated seeds was done daily and lasted six days. Results were expressed in percent germination. Mean time of seed germination (MTSG) was also calculated according to the formula:

$MTSG = \Sigma n_i \times T_i / \Sigma n_i$

T_i is the initial time and n_i the number of germinated seeds between T_{i-1} and T_i.

Statistical analysis was done on $\arcsin\sqrt{x}$ transformed data. Mean comparisons were done by the Newman Keuls test.

RESULTS

Effect of NaCl on germination

Daily percent germination were calculated for NaCl treatments and genotypes. Statistical analysis showed significant differences among genotypes and NaCl concentrations (Table 1) with no significant effect on their interaction. Average percent of germination declined as NaCl concentration increased.

Table 1: Results of analysis of variance, values and levels of significance of F for daily percent of sunflower seed germination computed over genotypes and NaCl concentrations

Variable	NaCl	Genotype	NaCl x Genotype	Standard deviation	CV (%)
TMG	12.67***	49.52***	3,35**	0,35	13,78
PGT1	50.05***	1.61 ns	1.37 ns	6.73	42.20
PGT2	14.87***	23.56***	1.88 ns	11.82	21.50
PGT3	8.56***	11.33***	1.37 ns	12.94	19.70
PGT4	7.13***	6.77**	1.18ns	13.53	19.50
PGT5	5.88***	3.55*	1.06 ns	14.18	9.80
PGT6	6.31***	3.23*	0.91 ns	13.84	18.80
PGT7	5.20**	2.89 ns	0.60 ns	14.66	19.60
PGT8	5.66***	3.54*	0.66 ns	13.91	18.30
PGT9	5.31**	3.96*	0.68 ns	13.86	18.14
PGT10	5.31***	4.59*	0.70 ns	13.57	17.60

PGT1-PGT10: percent of seed germination respectively after 1 and 10 days of incubation;
CV: coefficient of variation; ***: significant at 0.1%; **: significant at 1%;
*: significant at 5%; ns: not significant

After 24 h incubation (Figure 1), percent reduction of seed germination compared with control varied from 57% to 92% when NaCl concentration in the medium was increased from 50 to 125 mM while the decline reached 100% for 175 mM. Differences were small among the genotypes (Figure 2) but Flamme seemed to be more sensitive than the others. The highest percent of seed germination was obtained for control and the lowest (0%) for 175 mM NaCl (Figure 3). After 48 h incubation (Figures 4, 5 and 6) percent reduction of seed germination compared with control varied from 2% to 40% when NaCl concentration in the medium was increased from 50 to 125 mM. It reached 57% for 175 mM. Mean comparisons of salt treatments gave:

control > 50 mM = 75 mM = 100 mM = 125 mM > 175 mM

and that of genotypes gave:

Oro9 > Albena > Flamme.

After 10 days of incubation (Figures 7, 8 and 9) mean comparisons of final percent of germination of salt treatments gave:

control > 50 mM = 75 mM = 100 mM = 125 mM > 175 mM

and that of genotypes gave:

Oro9 > Albena > Flamme.

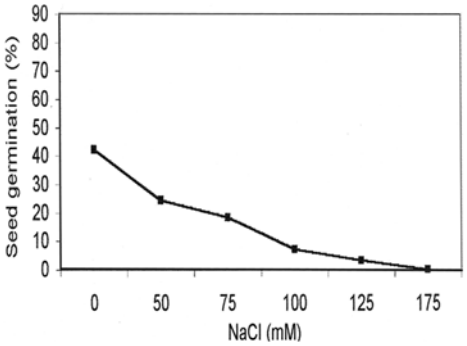

Figure 1: Mean over genotypes for percent germination of sunflower seeds after 24 h of incubation

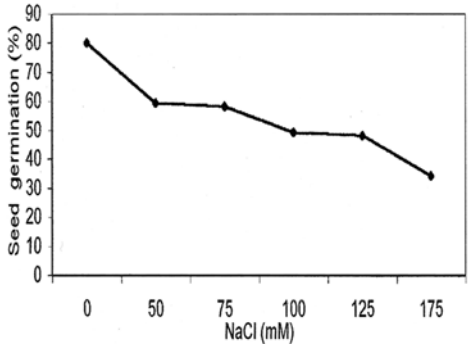

Figure 4: Effect of NaCl on mean over genotypes of percent germination of sunflower seeds after two days of incubation

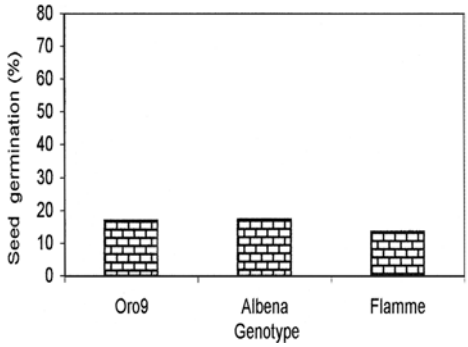

Figure 2: Mean over NaCl concentrations for percent germination of three sunflower genotypes after 24 h of incubation

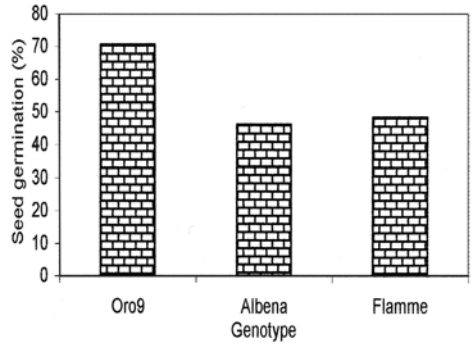

Figure 5: Mean over NaCl concentrations for percent germination of three sunflower genotypes after two days of incubation

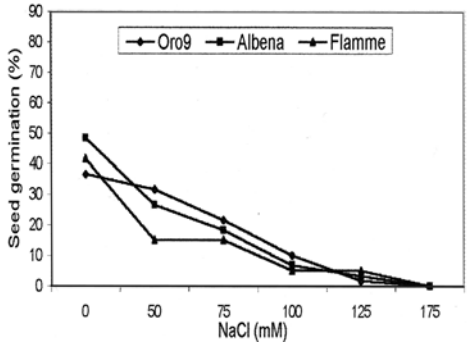

Figure 3: Effect of NaCl concentrations on seed germination (%) of three sunflower genotypes after 24 h of incubation

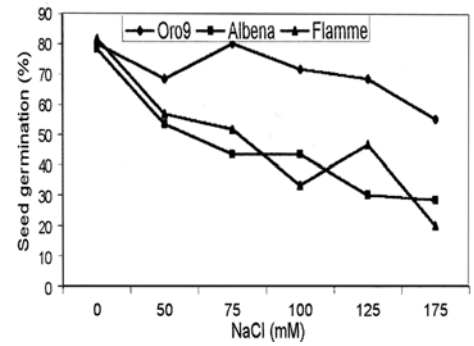

Figure 6: Effect of NaCl concentrations on seed germination (%) of three sunflower genotypes after two days of incubation

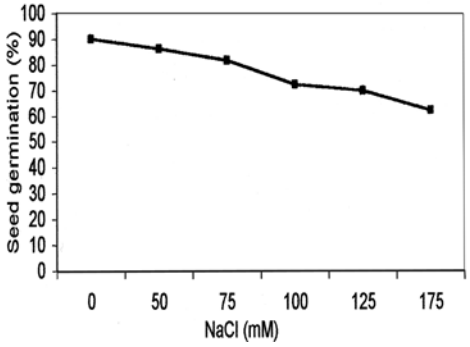

Figure 7: Effect of NaCl concentrations on overall mean of seed germination of sunflower after ten days of incubation

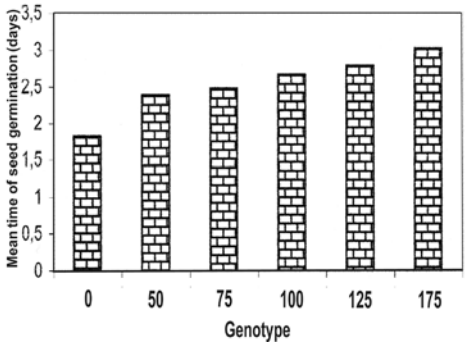

Figure 10: Effect of NaCl on overall mean time of seed germination of sunflower after ten days of incubation

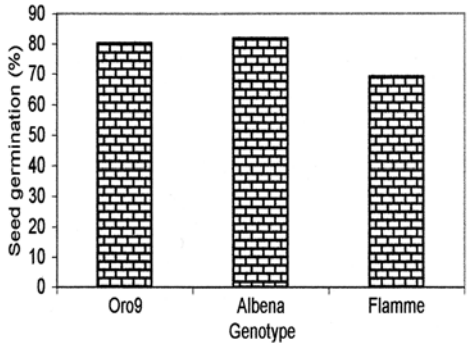

Figure 8: Mean over NaCl concentrations for seed germination of three sunflower genotypes after ten days of incubation

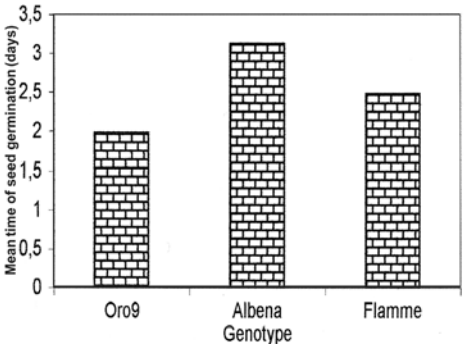

Figure 11: Mean time of seed germination over NaCl concentrations of three sunflower genotypes after ten days of incubation

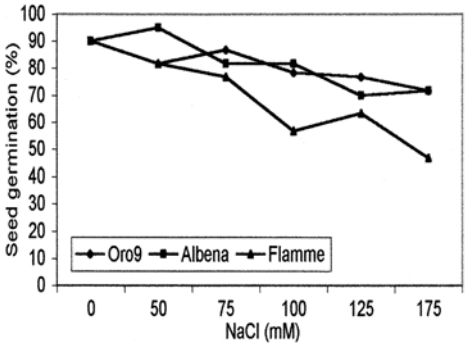

Figure 9: Effect of NaCl concentrations on mean seed germination of three sunflower genotypes after ten days of incubation

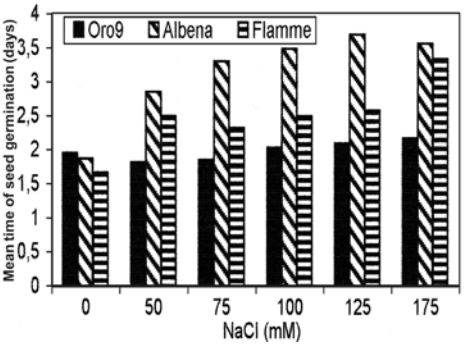

Figure 12: Effect of NaCl concentrations on mean time of seed germination of three sunflower genotypes after ten days of incubation

Comparison of NaCl concentrations results showed, for the tested genotypes, a close relationship between percent of seed germination after 48 h of incubation and after ten days of incubation. However, no significant differences were obtained among genotypes in control. Under saline condition significant genotype differences were recorded. Flamme was most sensitive (48% decrease at 175 mM) while Albena was least sensitive (20% decrease at 175 mM). Oro9 was in between. The sensitivity of the genotypes increased when NaCl concentration was increased in the medium.

Effect of NaCl on mean time of seed germination

Mean time of seed germination (MTSG) calculated over 10 days of incubation (Table 1) was significantly affected by salt treatments (P=0.0000) and genotypes (P=0.0000). Increasing NaCl concentration resulted in an increase of MTSG (Figure 10). Mean values varied from 1.83 days (control) to 3.02 days (175 mM) which is equivalent to an increase of 165%. Mean comparisons of NaCl treatments gave: 175 > 125 = 100 > 75 = 50 > control. Significant differences were also recorded among genotypes with Oro9 having the lowest MTSG and Albena the highest (Figure 11). This result suggested that seeds of Albena needed a significantly longer duration to germinate under saline conditions than the other genotypes. As for the percent of seed germination, the sensitivity of the genotypes increased when NaCl concentration was increased in the medium (Figure 12).

DISCUSSION AND CONCLUSION

Results showed that sunflower germination was depressed when we increased NaCl concentration. The decline of seed germination under salt conditions might result in part, as reported by several workers (Greeway and Munns, 1990; Rawson *et al.*, 1988; Bizid *et al.*, 1988), from a decrease of water influx which reduces seed humectation required for metabolic reaction involved in seed germination processes. At the end of the experiment, a variety population Oro9 and a hybrid Albena showed similar response to salt. Although high concentration of NaCl in the medium induced a significant seed germination delay compared with control, their percent of seed germination remained always higher than that of Flamme. It was noticed also that seeds of Oro9 had germinated earlier than those of the two hybrids whose percents of seed germination were not significantly different during the five days of the experiment. Beyond the fifth day, rate of seed germination of Albena became higher than that of Flamme. These differences might be attributed, as reported by Tanczos *et al.* (1988), to the ability of the embryo of tolerant genotypes to limit salt influx to maintain a non-toxic level of NaCl within embryo cells.

Results showed that a delay of seed germination in the presence of NaCl varied among the genotypes. The delay increased with NaCl concentration. It reached for example 6 days at 100 mM NaCl for Oro9 and 8 days for Flamme. Similar findings

were reported by Simoneau and Aubert (1963) on wheat. The delay of seed germination will certainly have a negative effect on growth and yield of the genotype. Mean time of seed germination was also dependent on NaCl concentration.

Although further investigations are needed to ascertain present result, some conclusions may be drawn from these findings. There were clear and significant differences among the tested genotypes which means that yield loss could be expected to be high for varieties with low percent seed germination and high mean time of seed germination. Expected loss will result from reduced plant population coupled with low compensation among yield components.

REFERENCES

Abel, G.H. and Mackenzie, A.T., 1964. Salt tolerance of soybean (*Glycine max*) varieties during germination and later growth. Crop Sci. 4: 157-162.

Ashraf, M., Waheed, A., 1990. Screening of local/exotic accessions of lentil (*Lens culinaris* Medic) for salt tolerance at growth stages. Plant and Soil 128: 167-176.

Bizid, E., Zide, E., Grignon, C., 1980. Tolerance a NaCl et selectivite K^+/Na^+ chez les triticales. Agronomie 8: 23-27.

Blamey, F.P.C., Asher, C.J. and Edwards, D.G., 1986. Salinity effects on sunflower growth in solution culture. In: Proc. Aust. Sunflower Assoc. Workshop, 6th Gunnedah, New South Wales. Australian Sunflower Association, Toowoomba, Australia, pp. 67-71.

Greenway, H., Munns, R., 1980. Mechanisms of salt tolerance in non halophytes. Ann. Rev. Plant. Physiol., 31: 149-190.

Hardwick, R. and Ferguson, D., 1978. Germination and hypocotyl growth in *Helianthus annuus* L. as influenced by differential salt treatments. In: Proc. 8th Int. Sunflower Conf., Minneapolis, MN, 23-27 July. Int. Sunflower Assoc., Paris, France, pp. 385-399.

Heikal, M.M., Ahmad, A.M. and Shaddad, A., 1980. Changes in dry weight and mineral composition of some oil producing plants over a range of salinity stresses. Biologia Plantarum, 22(1): pp. 25-33.

Jana, M.K. and Stinkard, A.E., 1979. Screening for salt tolerance in lentils. Lens 6: 25-27.

Katerji, N., Van Hoorn, J.W., Hamdy, A., Karam, F. and Mastrorilli, M., 1994. Effect of salinity on emergence and on water stress and early seedling growth of sunflower and maize. Agric. Water Manage. 26: 81-91.

Katerji, N., Van Hoorn, J.W., Hamdy, A., Karam, F. and Mastrorilli, M., 1996. Effect of salinity on water stress , growth and yield of maize and sunflower. Agric. Water Manage. 30: 237-249.

Katerji, N., Van Hoorn, J.W., Hamdy, A, Karam, F., Mastrorilli, M., 2000. Salt tolerance classification of crops according to soil salinity and to water stress day index. Agric. Water Manage. 43: 99-109.

Maas, E.V., Hoffman, G.J., 1977. Crop salt tolerance, current assessment. J. Irrig. Drain. Div. ASCE 103: 115-134.

Rawson, H., Long, M., Munns, R., 1988. Growth and development in NaCl treated plants. I. Leaf Na^+ and Cl^- concentrations do not determine gas exchange of leaf blades in barley. Aust. J. Plant Physiol. 19: 332-340.

Shaller, C.W., Berdegve, J.A., Dennett, C.W., Richards, R.A. and Winslow, M.D., 1981. Screening the world barley collection for salt tolerance. Proc. 4th Intern. Barley Gen. Symp. pp 389-393.

Simoneau, P., et Aubert, G., 1963. L'utilisation de l'eau salée au Sahara. Ann. Agron. 14(5): 859-872.

Srivastava, J.P and Jana, S., 1984. Screening wheat and barley germplasm for salt tolerance. In: Salinity Tolerance in Plants. Eds R.C. Staples and G.H. Toenniessen. John Wiley and Sons. New York, pp. 273-283.

Vulkan-Levy, R., Ravina, I., Mantel,l A. and Frenke,l H., 1998. Effect of water supply and salinity on pima cotton. Agricultural Water Management 37(2): 121-132.

INFLUENCIA DE CLORURO DE SODIO EN GERMINACIÓN DE LA SEMILLA DE GIRASOL (*Helianthus annuus* L.)

RESUMEN

La semilla de tres genotipos de girasol (Oro9, Flamme y Albena) estaban germinando en las placas de petri, colocadas en una incubadora, y conservadas en la temperatura de 28ºC. La semilla se mojaba con seis concentraciones de NaCl (0, 50, 75, 100, 125 y 175 mM). Los resultados han demostrado que en todos los tres genotipos se ha producido la caída de germinación, con el aumento de concentración de NaCl en la base. Después de seis días de incubación, se notaron unas relevantes diferencias entre el control y las variantes tratadas. La comparación de los valores medianos de las diferentes variantes del experimento, han mostrado que no había significantes diferencias entre las variantes con 50 y 75 mM, ni entre las con 100 y 175 mM. Como el más sensible, se ha mostrado el genotipo Flamme. La concentración de NaCl, tanto como genotipo, tenía una influencia significante en el tiempo promedio de germinación.

EFFET DU CHLORURE DE SODIUM SUR LA FACULTÉ GERMINATIVE DU TOURNESOL (*Helianthus annuus* L.)

RÉSUMÉ

Les semences de trois génotypes de tournesol (Oro9, Flamme et Albena) ont été mises à germer dans des boîtes *petri* placées dans un incubateur dont la température était maintenue à 28°C. Six concentrations de NaCl (0, 50, 100, 125 et 175 mM) ont été utilisées pour humidifier les semences. Les résultats ont montré une diminution de la germination des trois génotypes avec l'augmentation de la concentration dans le bouillon de culture. Après six jours d'incubation des différences significatives ont été observées entre les lignes de contrôle et les variantes traitées. La comparaison moyenne des variantes traitées n'a pas révélé de différences significatives entre les variantes traitées 50 mM et 75 mM ni entre les variantes traitées 100 mM et 175 mM. Le génotype Flamme s'est montré le plus sensible. La concentration NaCl et le génotype ont tous les deux eu un effet significatif sur le temps moyen de germination de la semence.