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EFFECT OF OSMOTIC PRESSURE ON GERMINATION OF SUNFLOWER SEEDS (*Helianthus annuus* L.)

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SUMMARY

In arid and semi arid areas, water is the most limiting factor of crop production. Germination is susceptible to water shortage. Experimentation was undertaken to study the effect of water stress on germination of seeds of three sunflower genotypes (Oro 9, Mirasol and Albena). Six PEG 6000 osmotic constraints were tested (0, -0.4, -0.6, -1, -1.2 and -1.6 MPa). Results showed no significant difference between germination percent of the control and -0.4 MPa treatment and between -0.8, -1 and -1.2 MPa treatments. Germination percent was most reduced at -1.6 MPa (-65%). Mean germination duration was also affected and the highest value was obtained for -1.6 MPa (4.95 days, related to an increase of 185%). Differences between genotypes were significant in the treatment at -1 MPa.

Key words: sunflower, osmotic pressure, germination

INTRODUCTION

Crop plants showed different resistance levels to environmental stress. Selection of genotypes adapted to stern conditions, based on genetic variability, is very useful for crop improvement. Screening procedures however have to be simple, reproducible and inexpensive. Some tests have been performed in laboratory. For many species, they were based on seed germination under different constraints. Relationship between seed germination tests and field results were not always significant.

Water stress is a limiting factor of sunflower production in arid and semi-arid areas through effects on seed germination duration and seedling growth (Shanon &

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François, 1977). Some researchers, such as Edje and Burris (1971), considered that seed vigour was linked to the speediness and uniformity of germination and also to the growth rate of seedlings under field conditions. PEG was commonly used to induce water stress in laboratory experiments (Smith *et al.*, 1989; Livingston *et al.*, 1990).

Reduction of percentage of germination under water stress was reported by several scientists (Ashraf and Abu-Shakra, 1978; Sharma, 1973; Thill *et al.*, 1979). Hadas (1977) compared germination percent of many species under water stress and found a narrow correlation between germination percent under controlled and field conditions. Somers *et al.* (1983) used a germination test on sunflower genotypes submitted to PEG water stress as a screening tool and concluded that it could be used as a screening test.

The purpose of the present study was to compare the germination ability of three sunflower genotypes under different levels of PEG induced osmotic pressure.

MATERIALS AND METHODS

Twenty-five seeds of each genotype (Oro 9, Mirasol, Albena) were incubated at 27°C in dark conditions in Petri dishes between two wetted sheets of filter paper (Whatmann n°1). Five different PEG 6000 solutions were used to moist filter papers: water (control), -0.4 MPa, -0.8 MPa, -1 MPa, -1.2 MPa and -1.6 MPa solutions. Petri dishes were arranged in a complete randomized design in three replications. Germinated grains were counted daily over a seven-day period. Results were expressed as germination percent or as mean duration time of germination (MTG) calculated by the formula: MTG = Sni*Ti/Sni, where ni = number of germinated seeds between Ti-1 and Ti. Ti corresponds to the initial starting time of the experiment.

Table 1: Variance analysis. F values and significance probabilities for percentage of germination over duration (treatments and genotypes were pooled)

Variables	PEG	VAR	PEG*VAR	Et	CV (%)
MTG	86.73***	22.79***	3.26**	0.27	6.5
PGT1	145.45***	0.98NS	0.98NS	3.61	60.9
PGT2	84.44***	21.09***	7.00***	4.68	50.6
PGT3	15.46***	8.14**	7.49***	3.31	44.3
PGT4	41.71NS	1.22NS	6.40***	3.85	33.7
PGT5	2.15NS	4.90NS	1.51NS	5.16	40.8
PGT6	5.73***	7.48**	1.97NS	4.52	43.3
PGTT	142.50***	14.85***	1.56NS	6.42	11.1

PGT1 to PGT6: percentage of seed germination successively after 1and 6 days after incubation
PGTT: total percentage of seed germination seven days after incubation

PEG: polyethylene glycol
VAR: variety
Et: error standard
CV: coefficient of variation

***: significant at p = 0.001
**: significant at p = 0.01
*: significant at p = 0.05
NS: not significant at p = 0.05

RESULTS

Seeds in the control dishes started to germinate 24 h after incubation (Figure 1). At that time, percentage of seed germination was 41%, 32%, and 33% for Oro 9, Mirasol and Albena, respectively, PEG-induced stress resulted in a delay in seed germination for the three genotypes. The delay increased together with osmotic pressure (Figure 2).

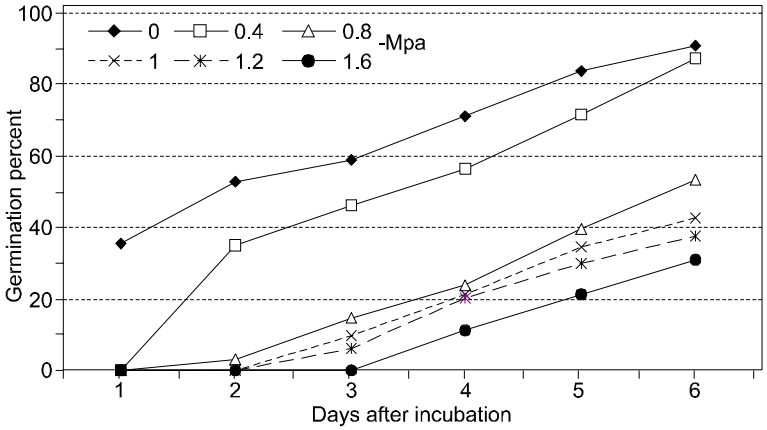

Figure 1: Effect of osmotic pressure on percentage of germination (mean value of three genotypes)

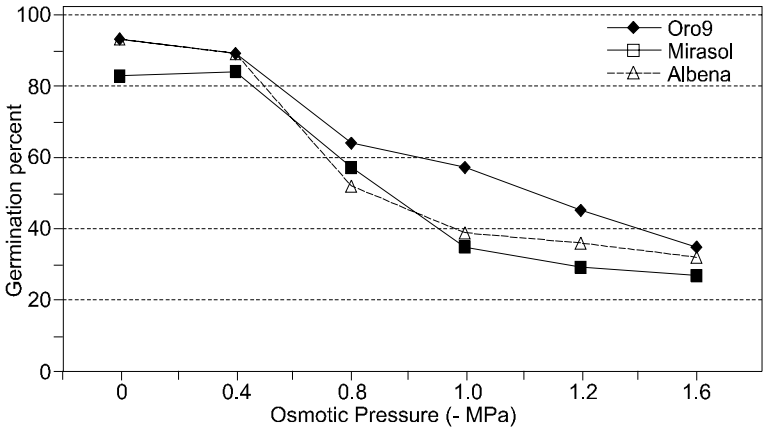

Figure 2: Effect of osmotic pressure on percentage of germination, after seven days of incubation

A latency of one day was recorded at -0.4 MPa, with longer germination period at -0.8 MPa. We noticed that seeds of Oro 9 germinated with the same rate at -0.4 and -0.8 MPa. Compared with Oro 9, the mean germination rate of the hybrids was delayed by one day. Percent of germination at the third day of incubation at –0.8 MPa was 25%, 7% and 3% for Oro 9, Mirasol and Albena, respectively.

Concerning the three treatments (-1, -1.2 and -1.6 MPa), variance analysis showed a significant effect of osmotic pressure on mean duration of the seed germination for the three genotypes (Table 2).

Table 2: Effect of osmotic pressure (OP) on mean duration time (MTG) and final percentage of germination (PGTT), of three sunflower genotypes, after seven days of incubation

	OP	0 MPa	-0.4 MPa	-0.8 MPa	-1 MPa	-1.2 MPa	-1.6 MPa
TMG	Oro9	2.22a	3.01b	3.87b	4.45a	4.40a	4.73a
	Mirasol	2.76a	3.72a	4.73a	4.59a	4.66a	5.11a
	Albena	3.07a	4.12a	5.02a	4.36a	4.41a	5.02a
	Mean	2.67d	3.67c	4.54b	4.47b	4.49b	4.95a
PGTT	Oro9	93.33a	89.33a	64.00a	57.31a	45.33a	34.67a
	Mirasol	82.67b	84.00a5	7.33a	34.67b	29.33a	26.67a
	Albena	93.33a	89.33a	52.00a3	8.67b	36.00a	32.00a
	Mean	89.78a	87.54a	57.78b	43.55c	36.89d	31.11d

Newman and Keuls test. Same letters indicate no statistical differences, at p = 0.05

Seeds of the genotype began to germinate solely by the third day, when incubated at -1 or -1.2 MPa, and by the fourth day when incubated at -1.6 MPa. Germination percentages after seven days incubation are given in Table 2 and Figure 3. They showed a significant treatment effect on final percentage of germination. Reduction of the value of this parameter by more than 50% was recorded at -1 MPa (51.49%), -1.2 MPa (58.91%) and at -1.6 MPa (65.35%). Under experimental condition, only two treatments, control and -1 MPa, allowed significant discrimination of the genotypes (Table 2). Therefore, considering the total germination percent in controls, two groups of genotypes could be distinguished: Oro 9 and Albena as a first group and Mirasol as a second one. At -1 MPa, Oro 9 had the highest percentage of germination.

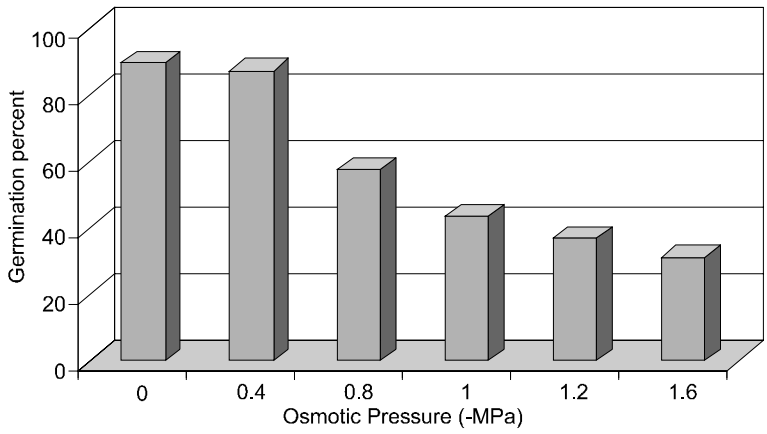

Figure 3: Effect of osmotic pressure on the final percentage of germination of sunflower seeds (mean value of three genotypes)

Results (Table 2) indicated significant effects for PRG treatments, genotype and genotype * treatment interactions for mean duration time of germination. This traits enhanced when osmotic pressure increased and was lowest in the control (2.67 days) or the highest in -1.6 MPa treatment (4.95 days). Genotype effect was significant at -0.4 and -0.8 MPa and two groups may be distinguished: Mirasol and Albena with high mean germination duration (MTG) and Oro 9 with low germination.

DISCUSSION AND CONCLUSION

Results of this experiment showed that osmotic pressure and genotype exerted significant effects on both percentage of germination and mean germination duration (MTG). Under osmotic stress, total percentage of germination was significantly reduced, except for -0.4 MPa treatment. Germination percentage was lowered to 2.5% at -0.4 MPa till 65.4% at -1 MPa. These results were similar to those reported by Shanon and François (1977), Smith *et al.* (1989), and Livingston *et al.* (1990). Effect of osmotic pressure was evidenced at the first day of incubation. The delay of germination and the reduction of percentage of germination under induced PEG water stress varied significantly between treatments. The highest duration of germination (4.95 days) and the lowest total percentage of germination (31.11%) were recorded at -1.6 MPa. When submitted to different level of osmotic pressures, the population Oro 9 performed better than the hybrids. However, it was only in -1 MPa treatment that significant differences between genotypes were observed. These results suggested that these treatments might be used to predict tolerance or susceptibility of important genotype series subjected to moderate water stress. Further experiments performed with different growth stages will be required to check relations between early germination tests and dry matter production under different levels of water stress.

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EFECTO DE LA PRESION OSMOTICA SOBRE LA GERMINACION DE SEMILLAS DEL GIRASOL (*Helianthus annuus* L.)

RESUMEN

En las regiones secas y semisecas, el agua es el factor limitante mas importante en la produccion vegetal. La germinacion es la fase sensible con respecto a la falta de agua. Los experimentos fueron efectuados para estudiar el efecto del estres de agua sobre la germinacion de semillas de tres genotipos del girasol (Oro 9, Mirasol y Albena). Fueron investigados seis niveles de reduccion de la presion osmotica por medio de PEG 6000 (0, -0.4, -0.6, -1, -1.2 y -1.6 MPa). Los resultados obtenidos mostraron que no existian las diferencias importantes en el porcentaje de germinacion entre el control y tratamiento de 0.4 MPa asi como entre los tratamientos de -0.8, -1 y -1.2 MPa. El porcentaje de germinacion era reducido por lo mas con el tratamiento de -1.6 MPa (-65%). La duracion media de la germinacion era tambien bajo la influencia del estres, y el valor maximo fue obtenido para el tratamiento de -1.6 MPa (4,95 dios, o la prolongacion del periodo por 185%). Las diferencias entre los genotipos eran importantes en el tratamiento de -1 MPa.

INFLUENCE DE LA PRESSION OSMOTIQUE SUR LA GERMINATION DE LA SEMENCE DE TOURNESOL (*Helianthus annuus* L.)

RÉSUMÉ

Dans les régions arides ou semi-arides, l'eau est le facteur limitatif le plus important de la production agricole. La germination est une phase sensible au manque d'eau. Des expériences ont été faites dans le but d'examiner l'influence du stress dû au manque d'eau sur la germination des semences de trois génotypes de tournesol (Oro 9, Mirasol et Albena). Six niveaux de diminution de pression osmotique ont été examinés à l'aide de PEG 6000 (0, -0.4, -0.6, -1, -1.2 et -1.6 MPa). Les résultats obtenus ont montré qu'il n'y avait pas de différences importantes dans le pourcentage de germination entre le groupe contrôle et le traitement -0.4 MPa ainsi qu'entre le traitement -0.8, -1 et -1.2 MPa. Le pourcentage de germination a été le plus significativement réduit par le traitement -1.6 MPa (-65%). La durée moyenne de germination a aussi été influencée par le stress et la plus grande valeur a été obtenue pour le traitement -1.6 MPa (4,95 jours, ou une période prolongée de 185%). Les différences entre les génotypes ont été importantes dans le traitement -1 MPa.