Marañon, T. (1989), *Seed Sci. & Technol.*, 17, 583–588

Variations in seed size and germination in three *Aegilops* species

T. MARAÑON

Instituto de Recursos Naturales y Agrobiología, C.S.I.C., Apdo. 1052, Sevilla 41080, Spain

(Accepted October 1988)

Summary

Diaspores of three *Aegilops* species, *A. neglecta*, *A. geniculata* and *A. triuncialis*, were collected in dry grassland in S.W. Spain. The seeds were classified according to position in the diaspore (detached spike), weighed individually and their germination tested. Large-type seeds of the three species started to germinate within 24 hours, while small-type seeds exhibited some delay or reduction in germination.

Résumé

*Variation de la taille des semences et de la germination chez trois espèces d'*Aegilops

Les diaspores de trois espèces d'*Aegilops*, *A. neglecta*, *A. geniculata* et *A. triuncialis*, ont été récoltées dans une prairie xérophile du Sud-Ouest de l'Espagne. Les semences ont été classées selon leur position dans la diaspore (épi détaché), pesées individuellement et leur germination a été testée. Les semences de grande taille des trois espèces commençaient à germer après 24 heures, tandis que la germination des semences de petite taille était retardée ou incomplète.

Zusammenfassung

Änderungen der Samengröße und der Keimfähigkeit bei drei Aegilops*-Arten*

Ährchen von drei *Aegilops*-Arten (*A. neglecta*, *A. geniculata* and *A. triuncialis*) wurden in einem trockenen Grünland in Südwestspanien gesammelt. Die Früchte wurden ihrer Position in den Ährchen (abgebrochene Ähren) nach sortiert und einzeln gewogen, und es wurde ihre Keimfähigkeit bestimmt. Die Früchte des großen Typs der drei Arten fingen innerhalb von 24 Stunden an zu keimen, während die Samen des kleinen Typs eine Keimverzögerung oder Keimfähigkeitsminderung zeigten.

Introduction

Heterogeneity in the germination of seeds has been found in homogeneous, selected populations of wheat (*Triticum aestivum* L. emend Fiori et Pad), and has been related to the size of the seed and its position in the spike (Chaussat and Bouinot, 1975). Several studies of wild relatives, *Aegilops* species, have also shown seed heteromorphism (*sensu* Venable, 1985) in size and germination potential (Wurzburger and Les-

hem, 1969; Datta, Evenari and Gutterman, 1970; Datta, Gutterman and Evenari, 1972; Marañon, 1987).

In this study, the germination of seeds in relation to their size and position in the spike was studied in three populations of *A. neglecta* Req. ex Bertol., *A. geniculata* Roth and *A. triuncialis* L. respectively, coexisting in dry grassland of S.W. Spain.

Materials and methods

Diaspores (detached spikes) were collected in dry grassland, on granitic soil, in S.W. Spain (37° 40′N 5° 55′W). Site elevation was 300 m, with mean annual precipitation of 754 mm. During October 1985 – June 1986 (seeds were harvested in July 1986) the total precipitation was 582.5 mm.

Diaspores were stored in paper envelopes at room temperature until germination experiments were carried out in 1987. One hundred diaspores of each species were chosen randomly, and the seeds contained were counted, weighed individually and classified according to their position in the diaspore (spike).

Seeds of the same type were grouped and placed in petri dishes, over filter paper moistened with 4 ml of distilled water, kept in the dark (wrapped in aluminium foil), and located at random in a growth chamber with alternating temperatures, 25°C (16 hours)/15°C (eight hours). Seeds with radicle emergence were considered as 'germinated' and counted daily until the 15th day. Germination time (GT) was calculated as the inverse of the coefficient of velocity (Scott, Jones and Williams, 1984).

Results and discussion

Seed type and weight

Diaspores of *A. neglecta* and *A. geniculata* contained 1–5 seeds (average 2.27 and 2.81 respectively) and those of *A. triuncialis* up to eight seeds (average 4.84) (figure 1).

The general structure was 1–3 pairs of seeds in the basal spikelets (one larger and lighter and the other smaller and darker), and 1–3 solitary small seeds in the terminal spikelets.

The spike was detached by the 1st or 2nd basal, sterile spikelet. Within the diaspore, seeds in the first spikelet in the base were named L1 (large) and S1 (small), and the same for the second (L2, S2) and third (L3, S3) two-seeded spikelets (the latter type is only found in *A. triuncialis*). Solitary seeds could be found in the 2nd (Ss2), 3rd (Ss3), 4th (Ss4) and 5th (Ss5) terminal spikelets (the latter two types only in *A. triuncialis*). Table 1 shows the number and weight of seeds of each type contained in 100 diaspores for the three *Aegilops* species.

Number of seeds per diaspore and spike structure were very similar in *A. neglecta* and *A. geniculata*, but the mean weight per seed was twice as great in the former species. *A. triuncialis* seeds were similar in size to *A. geniculata*, but the number of seeds per diaspore was almost double, with numerous small (S and Ss types) seeds. S-type/L-type seed ratios were 1.08 (*A. neglecta*), 1.21 (*A. geniculata*) and 2.18 (*A. triuncialis*) respec-

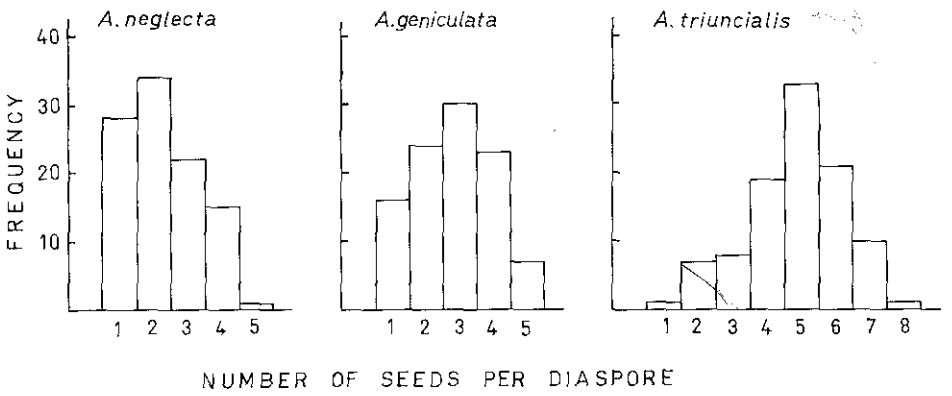

Figure 1. Frequency of diaspore types (N = 100) according to the number of seeds contained inside, for three *Aegilops* species.

tively.

Marañon (1987) studied the seed size in a nearby population of *A. neglecta* in 1985. The average seed number per diaspore was 3.0, with an S/L seed ratio of 1.35. The average seed weight was 36.10 mg for the L type, 13.32 mg for the S/Ss type and 22.96 mg as total average. Therefore, seed production per diaspore was higher in 1985 than in 1986, probably related to a higher precipitation in 1984–'85 (944 mm) than in 1985–86 (583 mm). The increase in total seed weight was due to larger L seeds (similar number but 35% heavier) and more numerous S/Ss seeds (58% more seeds but of similar weight). It seems that the over supply of photosynthate in 1985, as

Table 1. Mean weight of different seed types (see text) in three *Aegilops* species. Between brackets, number of seeds in 100 diaspores.

Seed type	Mean seed weight (mg) ± S.E.					
	A. neglecta		*A. geniculata*		*A. triuncialis*	
L1	26.91 ± 0.75	(100)	13.23 ± 0.34	(95)	14.30 ± 0.36	(100)
L2	25.32 ± 1.38	(18)	10.22 ± 0.61	(32)	13.08 ± 0.34	(48)
L3	–	(0)	–	(0)	8.28 ± 0.42	(4)
S1	13.47 ± 0.67	(64)	7.41 ± 0.26	(71)	6.40 ± 0.27	(71)
S2	8.92 ± 0.69	(18)	5.18 ± 0.37	(32)	4.88 ± 0.20	(48)
S3	–	(0)	–	(0)	2.93 ± 0.50	(4)
Ss2	13.89 ± 1.81	(26)	8.61 ± 0.63	(39)	10.49 ± 0.50	(50)
Ss3	6.00	(1)	3.21 ± 0.68	(12)	3.72 ± 0.19	(77)
Ss4	–	(0)	–	(0)	2.57 ± 0.14	(66)
Ss5	–	(0)	–	(0)	2.09 ± 0.29	(14)
Average	20.06 ± 0.55	(227)	9.43 ± 0.26	(281)	7.85 ± 0.24	(484)

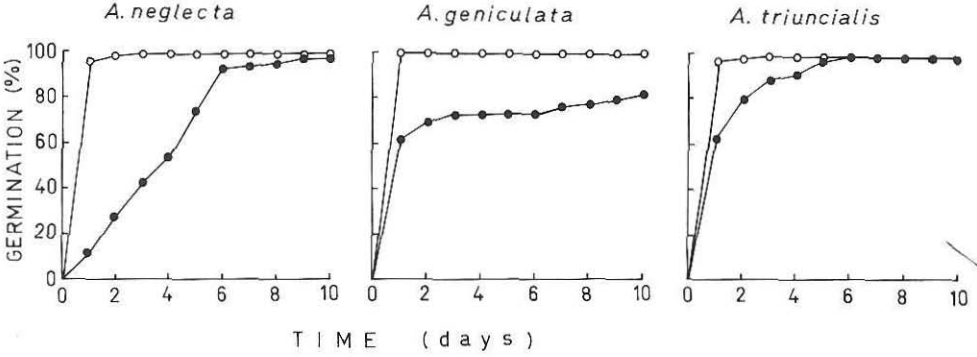

Figure 2. Germination (radicle emergence) of L (○) and S/Ss (●) types of seeds (see text) in three *Aegilops* species.

compared to 1986, was used to fill the L seeds up to their maximum size and to fill more S/Ss seeds in terminal spikelets.

Datta *et al.*, (1970) collected diaspores of *A. geniculata* from a roadside in Israel, but unfortunately they did not record the distribution of seed number and size per diaspore. They described a diaspore with four fertile spikelets (their type IV) not found in this study. Their values of average seed size (from five replicates): 12.9–17.7 mg for L seeds and 3.3–9.3 mg for S/Ss seeds are comparable to those observed in the S.W. Spain population.

In greenhouse experiments, Datta *et al.*, (1972) demonstrated that the weight of *A. geniculata* seeds is extremely plastic. Under long photoperiod (18 hours) and low temperature (15/10 °C), plants produced heavier seeds, e.g. 20.6–27.3 mg for L1 seeds, and 12.1–15.9 mg for S1 seeds, whereas with a short photoperiod (eight hours) and high temperature (28/22 °C), lighter seeds were produced, e.g. 11.3–11.8 mg for L1 and 4.8–6.7 mg for S1 seeds. However, the weight ratio between L1 and S1 seeds was kept close to two in all the treatments.

Seed germination

More than 90% of large (L type) seeds started to germinate (emerged radicle) within 24 hours for all three species (figure 2). Smaller seeds (S–Ss) showed some delay, 90% had started germination after four days in *A. triuncialis* and after six days in *A. neglecta*. One fifth (19%) of the small seeds of *A. geniculata* failed to initiate germination after 15 days (table 2).

Previous germination studies of *A. neglecta* (Marañon, 1987) and *A. geniculata* (Datta, Evenari and Gutterman, 1970) also showed rapid germination (starting within 24 hours) in L seeds and several days delay in the germination of S/Ss seeds.

In field conditions, seeds of *A. neglecta* are dispersed jointly in the same diaspore. After the first rains in autumn, large seeds germinate readily, but smaller seeds stay dormant inside the diaspore, at least for one year (Marañon, 1987). This secondary

Table 2. Germination percentage (GP) after 15 days and germination time (GT) (see text) for different seed types in three Aegilops species.

Species		Seed type									
		L1	L2	L3	S1	S2	S3	Ss2	Ss3	Ss4	Ss5
A. neglecta	GP	99.0	96.3	–	96.9	100	–	87.5	100	–	–
	GT	3.0	3.0		3.7	4.2		3.5	3.5	–	–
A. geniculata	GP	99.0	100	–	77.5	81.2	–	96.3	66.7	–	–
	GT	3.0	3.0	–	3.1	3.1	–	3.0	3.1	–	–
A. triuncialis	GP	97.0	100	100	98.6	97.9	100	100	98.7	97.0	92.3
	GT	3.0	3.0	3.0	3.2	3.3	3.4	3.0	3.2	3.3	3.3

dormancy seems to be induced by chemical inhibitors in the glumes and hulls of *Aegilops* diaspores (Wurzburger and Leshem, 1969; Datta, Gutterman and Evenari, 1972; Lavie, Cohen, Evenari and Gutterman, 1974).

Seed heteromorphism (*sensu* Venable, 1985), that is, seeds with different germination patterns produced by the same mother plant, could be produced by 'somatic heterochrony', an ontogenic process of changes in developmental rates of seeds (Silvertown, 1983). According to this hypothesis, small, distal seeds would be dispersed in an immature state, and the germination response therefore delayed or reduced, the seeds becoming sensitive to germination inhibitors in the diaspore. However, Chaussat and Bouinot (1975) found that, in *Triticum aestivum*, smaller, distal seeds within the spikelet germinated faster.

The physiological factors governing seed size in wheat seem to be influenced by the supply of photosynthate and the sink capacity of the seeds (Martínez-Carrasco and Thorne, 1979). Research is needed on the physiological basis determining the somatic difference in the germination behaviour of *Aegilops* and *Triticum* species.

References

Chaussat, R. and Bouinot, D. (1975). Hétérogénéité de la germination des grains de l'épi de blé (*Triticum aestivum*). *Comptes Rendus de l'Académie des Sciences, Paris, Série D*, **281**, 527–530.

Datta, S. C., Evenari, M. and Gutterman, Y. (1970). The heteroblasty of *Aegilops ovata* L. *Israel Journal of Botany*, **19**, 463–483.

Datta, S. C., Gutterman, Y. and Evenari, M. (1972). The influence of the origin of the mother plant on yield and germination of their caryopses in *Aegilops ovata*. *Planta (Berlin)*, **105**, 155–164.

Lavie, D., Levy, E. C., Cohen, A., Evenari, M. and Gutterman, Y. (1974). New germination inhibitor from *Aegilops ovata* L. *Nature*, **249**, 388.

Marañon, T. (1987). Ecología del polimorfismo somático de semillas y la sinaptospermia en *Aegilops neglecta* Req. ex Bertol. *Anales del Jardín Botánico de Madrid*, **44**, 97–107.

Martinez-Carrasco, R. and Thorne, G. N. (1979). Physiological factors limiting grain size in wheat. *Journal of Experimental Botany*, **30**, 669–679.

Scott, S. J., Jones, R. A. and Williams, W. A. (1984). Review of data analysis methods for seed germination. *Crop Science*, **24**, 1192–1199.

Silvertown, J. W. (1984). Phenotypic variety in seed germination behavior: the ontogeny and evolution of somatic polymorphism in seeds. *American Naturalist*, **124**, 1–16.

Venable, D. L. (1985). The evolutionary ecology of seed heteromorphism. *American Naturalist*, **126**, 577–595.

Wurzburger, J. and Leshem, Y. (1969). Physiological action of the germination inhibitor in the husk of *Aegilops kotscyi* Boiss. *New Phytologist*, **68**, 337–341.