Indian J. Pl. Genet. Resources 3 (2) : 85-92, 1990

GERMINATION AND VIGOUR OF STORED SORGHUM PIGEON PEA AND GROUNDNUT SEEDS

Neeta Singh and P.P. Khanna

National Bureau of Plant Genetic Resources
Pusa Campus, New Delhi-110012

Seed lots of Sorghum, pigeonpea and groundnut harvested in different years and stored for durations varying from one to ten years (1977-1986) under controlled conditions of medium term storage (4°C/20% RH) were germinated under different temperatures and substrate moisture conditions. The germination and seedling vigour were studied to find out optimum conditions while monitoring seeds in gene bank. Minimum mean germination period was noted at intermediate levels of moisture content. Mean germination period was maximum at the lowest moisture level. Mean germination period decreased with the increase in temperature. Seed lot stored for longer duration had longer mean germination period than the seed lot stored for shorter duration. In sorghum and pigeonpea, maximum germination was observed at intermediate levels of water content irrespective of temperature of germination. Among the temperature studied, germination was maximum at 25°C. High moisture level and high temperature promoted shoot length. Seedling vigour decreased with a decrease in temperature. Effect of all the three factors viz. *temperature, moisture and year and their interaction was found significant at 5 per cent level.*

Germination capacity of seeds is strongly influenced by environmental factors such as temperature and water stress (McGinnier, 1960; Tadmore *et al*, 1969). Seeds stored under controlled conditions in a genebank are taken out for monitoring germination at regular intervals to ensure that viability does not drop to unacceptable low levels. In the genebank management, current advice provided by IBPGR is that the germination testing environment be able to provide within one test environment or procedure those conditions which enable all viable seeds of that species to be able to germinate. That is, the germination environment should not be stressful to even poor quality seeds. During monitoring, the maximum germination can not be achieved until the germination behaviour of stored seeds is known. In the present investigation, seed lots of three crops viz., sorghum, pigeonpea and groundnut, harvested in different years, and stored for varying durations were germinated under different temperature and moisture conditions. The details are given in Table-1. The germination response and seedling vigour were studied to find out the optimum conditions for germination while monitoring seeds stored in the genebank.

MATERIALS AND METHODS

The experiment was conducted at ICRISAT, Patancheru in September 1987 and subsequently at NBPGR, New Delhi. Seeds of sorghum, pigeonpea and groundnut stored in closed containers (Aluminium cans with rubber lined lids in case of sorghum and pigeonpea and plastic jars in case of groundnut) for various durations under controlled conditions of medium (4°C, 20% RH) term storage were used in this study. The seeds were stored at 7 ± 1% MC. The details of materials as well as the conditions of growth are shown below in Table-1.

Table 1. Duration of storage and conditions during germination of the various seeds lots

Crop/Identity	Year of harvest	Duration of storage (years)	Substrate moisture level (ml)	Temperature (°C)
Sorghum IS 11758	1977	10	2.5, 5, 10	15, 25, 35
	1984	3		
	1986	1		
Pigeonpea ICP-1	1981-82	5	5, 10, 20	15, 25, 35
	1982-83	4		
	1986-87	1		
Groundnut ICG-2851	1985	2	5, 10, 20	15, 25, 35
	1986	1		

The seeds were surface-sterilised with sodium hypochlorite (0.25 %) and germinated on top of filter paper (Whatman No. 181) moistened with measured amounts of water in petri-dishes, enclosed in polyethylene bags. Two replicates, each of 50 seeds, were used for the rate of germination, while four replicates, each of 50 seeds, were used to test germination and vigour.

Seeds of sorghum (radicle length 5 mm) and pigeonpea and groundnut (radicle 10 mm length) were considered as germinated. Germination counts were taken on each day for calculating the mean germination period. Final germination counts were made following ISTA Rules (Anon., 1985); shoot and root length were measured to quantify the vigour of seedlings.

Mean germination period was calculated following Ellis and Roberts, 1980.

$$\text{Mean germination period (days) } \overline{D} = \frac{\Sigma\,(D{-}n)}{\Sigma\, n}$$

Where n is the number of seeds which germinate (radicle emerged) and D is the number of days counted from the beginning of germination test.

The variance of germination time was calculated as :

$$\text{Variance of germination time (days)} = \frac{\Sigma\,[(\overline{D} - D)^2 n]}{\Sigma\, n}$$

The data were statistically analysed.

RESULTS AND DISCUSSION

Sorghum seeds harvested in 1977 and stored for 10 years did not germinate in any set of conditions. Minimum mean germination period at the same temperature was noted at intermediate moisture level of the substrate *viz.*, 5 ml in sorghum and 10 ml in pigeonpea and groundnut (Table 2). Mean germination period (reciprocal of the rate of germination) was maximum at the lowest moisture level *viz.*, 2.5 ml in sorghum and 5 ml in pigeonpea and groundnut. At the same moisture level, the mean germination period decreased with increase in temperature in all cases except at 35°C for sorghum seed harvested in 1984. A positive linear relationship between temperature and rate of germination in a seed population has been shown in previous studies (Covell *et al.*, 1986; Garcia-Huidoboro *et al.*, 1982). At the same temperature and substrate moisture level, seed lot stored for longer duration (relatively more aged seeds) had longer mean germination period than the seed lot stored for shorter duration (relatively less aged seeds). Previous studies have shown that loss in viability in aged seed lots was preceded by an increase in the mean time taken by surviving seeds to germinate and is a common feature of seed ageing (Ellis and Roberts, 1980). Temperature affected both the maximum fraction of seed germinated after a fixed period of time and the rate of germination. The analysis of variance showed that the effect of all the three factors *viz.*, temperature, moisture and year of harvest and their interactions were significant at 1 per cent except groundnut where it was significant only at 5 per cent level. Its interactions with other two variables *viz.*, moisture and temperature were not significant.

In pigeonpea, aged seeds did not germinate in water and temperature stress conditions especially at low temperature. Previous studies (Ellis and Roberts, 1981 and Ellis *et al.*, 1986, 1987 a) have shown that within a genotype seed quality can have a marked effect on the profile of total percentage germination with respect to temperature as well as the time required for germination. Three patterns of changing temperature requirements for seed germination during storage were described (Roos, 1980), resulting in the narrowing of temperature range for germination. Either the maximum or minimum germination temperature changes gradually or both change which results in the inability of seeds to germinate at one or both of the temperature extremes.

Table 2. Mean Germination period (days) of seeds of different crops at various temperature and moisture range

Crop/identity/ year of harvest	Temperature (°C)	Substrate moisture level (ml)		
Sorghum (IS 11758) 1984		2.5 ml	5.0 ml	10.0 ml
	15	5.69 (0.24)	4.43 (0.44)	4.60 (0.70)
	25	2.60 (1.72)	2.17 (0.23)	2.51 (0.82)
	35	3.39 (0.98)	2.21 (0.34)	2.34 (0.64)
Sroghum (IS 11758) 1986	15	3.37 (0.22)	3.12 (0.16)	3.20 (0.21)
	25	2.45 (0.24)	2.15 (0.15)	2.16 (0.17)
	35	1.72 (0.14)	1.43 (0.23)	1.63 (0.24)
		5 ml	10 ml	20 ml
Pigeonpea (ICP-1) 1981-82	15	0	0	0
	25	4.88 (0.32)	3.79 (0.61)	4.16 (0.77)
	35	0	2.75 (0.18)	3.19 (0.71)
Pigeonpea (ICP-1) 1982-83	15	0	4.83 (0.13)	0
	25	4.62 (0.31)	3.34 (0.44)	4.12 (0.73)
	35	3.70 (0.33)	2.73 (0.47)	2.70 (0.70)
Pigeonpea (ICP-1) 1986	15	5.50 (0.25)	4.40 (0.25)	4.70 (0.46)
	25	3.87 (0.23)	2.85 (0.41)	3.09 (0.40)
	35	3.40 (0.60)	2.23 (0.33)	2.40 (0.38)
Groundnut (ICG 2851 1985	15	5.55 (0.84)	4.55 (0.46)	4.88 (0.50)
	25	3.30 (0.66)	2.5 (0.47)	2.60 (0.24)
	35	2.70 (0.58)	2.4 (0.12)	2.05 (0.10)
Groundnut (ICG 2851) 1986	15	5.05 (0.64)	4.18 (0.61)	4.38 (0.65)
	25	3.20 (0.56)	2.4 (0.47)	2.35 (0.22)
	35	2.47 (0.41)	2.21 (0.42)	2.30 (0.37)

Values in parenthesis indicate the variance in germination time.

0 Values show lots which did not germinate.

In sorghum and pigeonpea, maximum germination was observed at intermediate levels of water content irrespective of temperature at which germination was carried out (Table 3). Therefore, this moisture level may be considered as optimum. Between the temperature, germination was maximum at 25°C. These results are in agreement with prescription of ISTA (Anon., 1985). High moisture level and high temperature promoted shoot length. Seedling vigour as measured by the length of shoot and root decreased with decrease in temperature. Among the seeds germinated at different temperatures, germination was the least at low temperatures. Although 35°C was optimum in terms of most rapid germination and maximum seedling vigour, it was noted that a large number of seedlings showed abnormalities at this temperature.

Table 3. Seed viability and seedling vigour observations at different temperatures and substrate moisture level

Crop identity Year	Temp. °C	Water content (ml)	Percent normal seedling	Percent abnormal seedling	Shoot length (cm)	Root length (cm)
Sorghum IS 11758 (1986)	35	2.5	65	28	1.73	6.1
		5.0	73	23	4.55	9.12
		10.0	71	16	6.22	8.58
	25	2.5	76	23	1.38	5.5
		5.0	81	10	4.0	7.16
		10.0	73	6	7.0	8.18
	15	2.5	56	0	0	1.43
		5.0	62	20	0.58	2.33
		10.0	58	16	0.60	3.5
Sorghum IS 11758 (1984)	35	2.5	49	27	1.0	5.2
		5.0	60	19	1.9	6.4
		10.0	59	16	2.0	7.6
	25	2.5	54	13	0.0	3.1
		5.0	61	9	1.7	3.4
		10.0	56	7	1.8	5.0
	15	2.5	28	15	0.0	1.3
		5.0	35	60	0.0	1.2
		10.0	31	8	0.0	2.5
Pigeonpea ICP 1(1986)	35	5.0	82	9	2.8	11.5
		10.0	92	1	6.8	5.5
		20.0	84	2	4.3	4.5
	25	5.0	92	4	2.1	6.2
		10.0	95	3	4.1	5.0
		20.0	93	4	4.4	5.8

Cont....

Table 3. (Contd.)

Crop identity Year	Temp. (°C)	Water content (ml)	Per cent normal seedling	Per cent abnormal seedling	Shoot length (cm)	Root length (cm)
	15	5.0	64	0	0.3	1.14
		10.0	75	0	0.80	2.18
		20.0	71	4	0.66	1.63
Pigeonpea	35	5.0	41	29	3.2	4.2
ICP 1(1982-83)		10.0	52	21	4.8	5.4
		20.0	48	20	5.7	5.6
	25	5.0	50	15	1.5	4.0
		10.0	64	18	3.4	4.4
		20.0	61	10	3.9	4.2
	15	5.0	0	0	0	0
		10.0	32	8	0.61	2.10
		20.0	0	0	0	0
Pigeonpea	35	5.0	0	0	0	0
ICP 1 (1981-82)		10.0	42	8	4.1	3.7
		20.0	38	7	3.5	3.1
	25	5.0	32	2	1.0	2.8
		10.0	51	1	1.5	2.2
		20.0	44	3	1.9	1.6
	15	5.0	0	0	0	0
		10.0	0	0	0	0
		20.0	0	0	0	0
Groundnut	35	5.0	71	20	1.7	5.1
ICG 2851 (1986)		10.0	82	15	1.5	6.5
		20.0	75	0	1.8	7.0
	25	5.0	84	0	1.6	4.0
		10.0	91	0	1.6	4.5
		20.0	90	9	1.0	7.3
	15	5.0	70	0	0.2	3.0
		10.0	85	0	0.4	4.5
		20.0	75	25	0.7	3.6
ICG 2851	35	5.0	73	25	1.5	3.9
(1985)		10.0	70	29	1.6	3.5
		20.0	79	23	2.0	4.82
	25	5.0	78	6	0.6	3.5
		10.0	80	0	1.0	4.07
		20.0	87	7	1.5	4.1
	15	5.0	31	15	0.5	1.5
		10.0	37	9	0.8	2.7
		20.0	35	10	1.5	3.0

Results show that the regime in which the seed population is tested can influence final germination markedly, as has been shown earlier (Ellis *et al.*, 1987 b). The significance of these results for monitoring germination of stored seed in the genebank is that, differences in germinability can be exhibited by seed lots stored for various duration, and also in response to the germination environment. The use of optimum temperature and moisture levels only could achieve maximum germination while monitoring genebank accessions.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. M.H. Mengesha, Leader, Genetic Resources Unit, ICRISAT, Patancheru (A.P.) for useful suggestions during the experiment and for reading the manuscript; also to Mr. R.L. Sapra and Dr. (Mrs) Ranjana Nagpal for statistical analysis.

REFERENCES

Anonymous 1985. International rules for seed testing. *Seed Sci. & Technol.* **13** : 307-520.

Covell, S., R.H. Ellis, E.H. Roberts and R.J. Summerfield. 1986. The influence of temperature on seed germination rate in grain legumes I.A. comparison of chick pea, lentil soybean and cowpea at constant temperature. *J. Exptl. Bot.* **37** : 705 715.

Ellis, R.H. and E.H. Roberts. 1980. Towards a rational basis for testing seed quality. *In* Seed Production (ed. P.D. Habblethwaite), 694 pp, Butterworths, London.

Ellis, R.H. and E.H. Roberts. 1981. The quantification of ageing and survival in orthodox seeds. *Seed Sci. & Technol.*, **9** : 373 409.

Ellis, R.H., S. Covell, E.H. Roberts, and R.J. Summerfield. 1986. The influence of temperature on seed germination rate in grain legumes II Intraspecific variation in chickpea (*Cicer arietinum*) at constant temperatures. *J. Exptl. Bot.* **37** : 1503-15.

Ellis, R.H., T.D. Hong and E.H. Roberts. 1987a. Comparison of cumulative germination and rate of germination of dormant and aged barley seed lots at different constant temperatures. *Seed Sci. & Technol.* **15** : 717-727.

Ellis, R.H., G. Simon and S. Covell, 1987b. The influence of temperature on seed germination rate in grain legumes. III A comparison of five faba bean genotypes at constant temperature using a new screening method. *J. Exptl. Bot.* **38** : 1033-1043.

Garcia-Huidoboro, J., J.L. Moneith and G.R. Squire. 1982. Time, temperature and germination of Pearl millet (*P. typhoides* S. & H). I constant temperature. *J. Exptl. Bot.* **33** : 288-296.

McGinnier, W.J. 1960. Effect of moisture stress and temperature on germination of six range grasses. *Agron. J.* **52** : 159.

Roos, E.E., 1980. Physiological, biochemical and genetic changes in seed quality during storage. *Hort. Sci.* **15** (6) : 781-784.

Tadmore, N.H., Y. Cohen, and Y. Hapaz. 1969. Interactive effect of temperature and osmotic potential on the germination of range plants. *Crop Sci.* 9 : 771-774.