Effect of Seed Size on Quality within Seed Lot of Pea and Correlation of Standard Germination, Vigour with Field Emergence Test

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Abstract: Seeds originating from the same seed lot contain different seed sizes and can affect seedling establishment, growth and yield. The objective of the present investigation was to observe the effects of seed size on seed quality within seed lot of pea crop. One commercial seed lot of pea cultivar (*Pisum sativum*) was size graded into three categories: large (seeds retained on a 2.36 mm screen), medium (seeds retained on a 2.0 mm screen) and small (ungraded). For statistical analysis, a completely randomized split plot design with twelve replicates (four replicates for each size grade) was used. Mean 1000 seed weight for each category was 250 g, 164 g and 126 g respectively. The graded seeds were tested for standard germination, vigour and field emergence. Large and medium size seeds have high seedling survival, growth and establishment under unfavourable condition, i.e. under field condition than small seeds. From the result of the AA test it can be suggested that to use as a carry-over seed it would be suitable to use the medium (average) size seeds. These findings support the hypothesis of larger seeds those have superior performance to small seeds as the relation was found significantly positive. It also concluded that a seed lot cannot be expressed as vigour by testing a sample of a lot as the lot consists of different sizes of seeds. [Nature and Science. 2009;7(4):72-78]. (ISSN: 1545-0740).

Key words: Correlation, field emergence, large seed, seed vigour, unfavourable condition.

Introduction

Quality seed increases the productivity of agricultural crops and always pay dividend to the growers. Among the quality attributes seed size and seed weight invariably expressed as seed density which is the most important. The seed size indicated the amount of reserve food supply for seedlings. Small and shrivelled seeds do not contain as much food to give the plant a vigorous start as the bold and plumby seed. In pea the pod produced earlier has larger in seed size than those produce later.

Seed size is the main factor that affects seeding rates. Environmental variation affects the seed size and results in production of smaller seeds under unfavourable conditions. Seeds thus produced affect the germination seed vigour, field stand and processing recovery (Dighe and Patil, 1981). The possible effect of seed size on germination is associated with the length of the structures that form the seedling, but not necessarily with the subsequent biochemical conversion of storage reserves into germinating tissues (Soltani *et al*. 2002). Wood *et al.* (1977) reported that the seed size does not affect the yield "per-se", but better field stand with vigorous seedlings helps to perform ideally under the existing environment. Bigger seeds are associated with greater seed vigour and germination (Maranville and Klegg, 1977; Kalingrayar and Dharmalingam, 1980, Dighe and Patil, 1981) in sorghum. Often farmer retained seeds, lacked seed vigour reflected in the seedling emergence, seedling vigour and seedling biomass (Marcroft *et al*, 1999).

Large seed size significantly increased seedling survival compared to small seed size by 25%. Results indicated that the post-sowing compaction and increased seed size may benefit seedling survival (Rohitha *et al*, 2004). The use of differing seed size physical parameters as discriminating criteria for seed among varieties and different species has been previously reported (Dehghan-Shoar *et al*. 1998; Illipronti *et al*. 1999; Keefe, 1999). Nerson (2002) showed that small muskmelon seeds had the lowest percentage germination, emergence, and the lowest seedling growth demonstrating that there is an association between seed physical parameters and seed quality.

The lack of relationship between seed size and germination could be explained by the more important influence of embryo size or weight; in general, larger seeds have larger embryos, which is associated with increased germination (Lopez-Castaneda *et al*. 1996). Further, Mian and Nafziger (1994) showed that different seed sizes influence the water potential and, therefore, the speed of germination. That difference can also affect the uniformity of germination and subsequent seedling development (Seiwa and Kenji, 2000) that causes a higher germination percentage in seeds with greater size, even though this may not necessarily occur with smaller seeds (Liu *et al*. 1993; Adkins *et al*. 1996; Duval and NeSmith, 2001). As seed size is a widely accepted measure of seed quality by different workers, study was conducted to determine whether seed size really affects seedling establishment and to its' vigour. Therefore, present investigation aims to observe the effects of seed size on seed quality within seed lot of pea crop.

Materials and Methods

The experiment was conducted on a commercial seed lot of pea cultivar (*Pisum sativum*), collected from local farming area of Uttarakhand (India). The seeds were graded into three categories: large (seeds retained on a 2.36 mm screen), medium (seeds retained on a 2.0 mm screen) and small (ungraded). Mean 1000 seed weight taken for each category was 250 g, 164 g and 126 g respectively. The graded seeds were tested for germination, vigour and field emergence. For statistical analysis, a completely randomized split plot design with twelve replicates (4 replicates for each size grade) was used.

Test Weight: The seed sample with highest seed weight (1000 seed weight) was considered as vigorous. The size of the seed was graded from a sample taken randomly of a seed lot.

Sand Method (SM*)*: Four replications (40 seeds to each replicate) for each seed size category were planted on Petri plates. Plates were placed in a germination chamber at 25ºC for 7 days. Normal and abnormal seedlings were assessed for percentage germination (ISTA, 2008) and dead seeds recorded.

Between Paper (BP): The seeds were germinated for 7 days in between two layers of papers by loosely covering the seeds with an additional layer of germination paper and placed on germination trays. Same temperature and condition were given as on the sand method. Assessments were also conducted according to the ISTA norms.

Accelerated Aging (AA): The dry seeds are subjected to accelerated aging test; stress of high temperature 42^0 C and near 100% relative humidity for 72 hours. For this four replicates for each size grade, 40 seeds to each replicate, were distributed over an aluminium screen in germination plastic boxes. The boxes were filled up with 40 ml of distilled water and kept in a germination chamber and then seeds were placed for germination test (ISTA, 1996).

Seedling Length (SL): Length of 5 normal seedlings grown in moist towel paper kept at optimum temperature (25^0C) at 45^0 was measured in cm on the day of final count. Separate measurement was taken for shoot and root. The sample showing maximum mean seedling length was considered as vigorous.

Seedling Dry Weight (SDW): The weight of seedling for each replicate was taken in gm, excluding the cotyledon on 8^{th} day after oven drying at 100^0C for 24 hr and noted. The sample exhibiting the maximum seedling dry weight was recorded and considered as vigorous.

Seedling Growth Rate (SGR): Twenty seeds were placed in straight line on a paper towel moistened with distilled water and kept at an angle of 45 in a germinator at a temperature of 25^0C. Only eight competitive normal seedlings were selected for observation and remaining seedlings were removed. For the next 5 days the length of each seedling was measured daily in cm. Seedling growth rate was determined by dividing the mean increase in length from each previous measure by the number of days the seedling had been in the germinator. Sum of each count at the end of the test period is expressed as seedling growth rate (Copeland, 1976).

$$SL1/F1 + (SL1 - SL2)/F2 + \ldots\ldots + [SLn - SL(n-1)] / Fn$$

Where, SL1 mean seedling length at first count
SL2 mean seedling length at second count
SL1-SL2 mean increase in length in second count

F1	days to first count
Fn	days to final count

Field Emergence (FE): Field experiments were carried out at the field Research Centre of Seed Science & Technology: 40 seeds to each replicate were manually sown in 1.5 m long and 0.25 m apart rows at 3 cm depth. Four plots were prepared for each seed size grade. Emerged seedling counting and evaluation was carried out when the seedlings showed well characterized apparent plumule over the soil surface.

Statistical analysis (Correlation coefficient): The data obtained from different test parameters were subjected to the Pearson correlation coefficient analysis. It is the mutual association between variables without implying any cause and effect relationship. In this analysis, simple correlation coefficients were computed between pair of characters using the SPSS program.

RESULTS AND DISCUSSION

Test weight v/s Field emergence: Test weight exhibited significant positive correlation with mean field emergence and negative correlation with standard germination tests (Table 1). Seed size was strongly correlated with days to germination; smaller seeds germinated faster than larger seeds. The time from sowing to emergence was significantly related to different seed sizes. Small seeds may be expected to imbibe water faster than large seeds, so small seeds may germinate faster. However, large seeds have more nutrients stored within the seeds so their plants may be expected to grow taller than plants from smaller seeds.

Between papers, Sand method v/s Field emergence: Mean maximum germination percent in between paper and sand test was recorded in small seed grade which was in contrast to field emergence percent (Table 1). But small seed grade reveals significant positive relationship between replications of germination and seedling emergence [Table 2(A) & 2(B)] in both the methods which contradicts the observations of Nerson (2002), Lopez-Castaneda *et al*. (1996). The findings on standard germination tests support the report of Calton and Edgar (1971). Moreover, mean experimental finding values (Table 1) apparently confirm that increase seed size affect decrease germination index, seedling length with enhance mean germination time which support the results of Kaya *et al.* (2008).

Accelerated aging v/s Field emergence: In the entire replications of different seed size grade, accelerated aging exhibited significant positive correlation with field emergence [Table 2(C)]. The mean maximum germination (90%) after accelerated aging was recorded in medium grade (Table 1) which showed that vigour test values can be directly used to predict field emergence. It also indicated that it has the property to retain its viability for prolong time period which support the findings of Aguiar (1979) and Rohitha *et al*, (2004), that average seed size may increase seedling survival than large and small seed size. The findings also support the hypothesis that large seeds have superior performance to small seeds or that small seeds have lower vigour under unfavourable conditions.

Seedling length v/s Field emergence: The Seedling length recorded from medium seed grade shows significant negative association with field emergence. But positive association was found in small and large size grade [Table 2(D)]. The mean maximum seedling length was recorded in small and medium grade with same result (Table 1). It explains that initial seedling size and length is positively related to seed size; the result was consistent to the reports of Moebenburg (1996), Kaya *et al.* (2008), Soltani *et al*. (2002). Improve seedling vigour by large-sized seed in field emergence and accelerated aging has been discussed by Murray *et al,* (1984).

Seedling dry weight v/s Field emergence: A significant negative correlation was found in medium size grade and significant positive relation in large and small seed grade [Table 3(E)]. But maximum mean seedling dry weight was recorded in medium grade followed by small and large (Table 1) which showed relationship with accelerated aging test value. The analysis showed that dry matter content is a component of seedling vigour. Faster dry matter component accumulation allows plants to better tolerate many stresses. But when the seedling vigour was concerned average or medium size seeds showed the high seed vigour and longevity which was in accordance of the report of Woodstock (1976) and Khare & Bhale (2000).

Seedling growth rate v/s Field emergence: A significant negative correlation was found with respect to seed size and mean field emergence (Table 1). This result can equate the report of Komba *et al*, (2007) that large seeds do not have superior performance to small seeds. The relation between seedling growth rate and field emergence test also supports the findings of Adkins *et al*. (1996). The lowest mean field emergence percentage was recorded in small seed and findings were consistent with those of Karivarhadaraaju *et al*. (2001) and Liu *et al*. (1993). Murray *et al*, (1984) found improved seedling vigour by large-sized seed and consistent result was found in field emergence and accelerated aging.

Table 1. Mean values of four replicates of different tests parameters with respect to different seed size grade. The values are expressed on the basis of number of normal seedlings after analysis. Test weight is expressed on mean 1000 seed weight.

Seed size grade (mm*)	TW (g)	BP	SM	AA	SL (cm)	SGR	SDW (g)	FE
Large (>4.5)	250	32.00	33.50	26.00	5.0	0.65	0.225	36.50
Medium (>3.35 & <4.5)	164	36.00	34.00	36.00	6.4	1.76	0.276	33.50
Small (<3.35)	126	38.00	36.00	28.50	6.4	2.03	0.231	25.50

Acronym: TW = Test weight, BP = Between paper, SM = Sand method, AA = Accelerated aging, SL = Seedling length, SGR = Seedling growth rate, SDW = Seedling dry weight, FE =Field emergence,
*size of aperture of the screen

Table 2. Correlation coefficient analysis by Spearman's 1-tailed method using SPSS program. The analysis is based on the values of replications of respective seed sizes. Relationships were analysed between Field emergence with Between paper (A), Sand method (B) Accelerated aging (C) Seedling length (D) Seedling dry weight (E). [Note: (**.**) Cannot be computed because recorded variables (values) are independent, but they are considered as no relation.]

Seed Size Grade		**Between Paper**	**Field Emergence**
Large	Correlation Coefficient	1.000	.738
	Sig. (1-tailed)	.	.262
	N	4	4
Medium	Correlation Coefficient	1.000	-.500
	Sig. (1-tailed)	.	.500
	N	4	4
Small	Correlation Coefficient	.	.
	Sig. (1-tailed)	.	.
	N	4	4

(A)

Seed Size Grade		**Sand Method**	**Field Emergence**
Large	Correlation Coefficient	1.000	.389
	Sig. (1-tailed)	.	.306
	N	4	4
Medium	Correlation Coefficient	1.000	.000
	Sig. (1-tailed)	.	.500
	N	4	4
Small	Correlation Coefficient	1.000	-.056
	Sig. (1-tailed)	.	.472
	N	4	4

(B)

Seed Size Grade		Accelerated Aging	Field Emergence
Large	Correlation Coefficient	1.000	.778
	Sig. (1-tailed)	.	.111
	N	4	4
Medium	Correlation Coefficient	.	.
	Sig. (1-tailed)	.	.
	N	4	4
Small	Correlation Coefficient	1.000	.056
	Sig. (1-tailed)	.	.472
	N	4	4

(C)

Seed Size Grade		Seedling Length	Field Emergence
Large	Correlation Coefficient	1.000	.211
	Sig. (1-tailed)	.	.395
	N	4	4
Medium	Correlation Coefficient	1.000	-.738
	Sig. (1-tailed)	.	.131
	N	4	4
Small	Correlation Coefficient	1.000	.105
	Sig. (1-tailed)	.	.447
	N	4	4

(D)

Seed Size Grade		Seedling Dry Weight	Field Emergence
Large	Correlation Coefficient	1.000	.632
	Sig. (1-tailed)	.	.184
	N	4	4
Medium	Correlation Coefficient	1.000	-.211
	Sig. (1-tailed)	.	.395
	N	4	4
Small	Correlation Coefficient	1.000	.316
	Sig. (1-tailed)	.	.342
	N	4	4

(E)

Conclusion

It may be concluded from this experiment that positive relation was found between large seed grade and field emergence in all the test parameters. However, standard germination values can't be directly used to predict field emergence. The research has revealed that large and medium size seeds have high seedling survival, growth and establishment under unfavourable condition, i.e. under field conditions. It also concluded that seed vigour differs among seed sizes in a seed lot. These data support the hypothesis that large seeds have superior performance to small seeds. The result also suggested that to use as a carry-over seed it would be suitable to use the medium size seeds.

References

Adkins, S., Boersma, M. and Law, M. Relationship between vigour tests and emergence of soybean when grown under a range of seedbed moisture conditions. *Australian Journal of Experimental Agriculture*, vol. 36, no. 1, 1996; Pp. 93-97.

Aguiar, P.A.A. Effect of seed size on germination and vigour of soyabean (*Glycine max* (L.) Merrill). In Anais, Vol. 2. 1. Seminario Nacional de Pesquisa de Soja. Londrina, Brazil; Centro Nacional de pesquisa de Soja. 1979; 325 – 332 (pt, en, 10 ref.).

Calton J. Edwards, Jr. and Hartwig, E. E. Effect of Seed Size upon Rate of Germination in Soybeans. Pub. in Agron. J. 1971; Pp. 63:429-450.

Copeland, L.O. Seed and seedling vigour. In principle of seed science and technology. Ed., L.O. Copeland, 1976: Pp. 149-184.

Dehghan-Shoar, Hampton, M., J. and Haslett, S. Identification of, and discrimination among, lucerne (*Medicago sativa* L.) varieties using seed image analysis. *Plant Varieties and Seeds*, vol. 11, no. 2, 1998; Pp. 107-127.

Dighe, R.S. & Patil, V.N. Effect of seed size on germination, vigour and yield in sorghum. P.K.V. Res. 1981; (1): 17-20.

Duval, J. and Nesmith, D. Difference in seed coat thickness between the cultivars. Resistance to gas diffusion through the seedcoat and hilum of watermelon (*Citrullus lanatus* Matsum & Nakai). *Proceedings of the Florida State Horticultural Society*, vol. 114, 2001; Pp. 323-326.

Illipronti, R., Langerak, C. and Lommen, W. Variation in physical seed attributes relates to variation in growth of soybean seedlings within a seed lot. *Seed Science and Technology*, vol. 27, no. 1, 1999; Pp. 339-357.

International Seed Testing Association. International Rules for Seed Testing, 1996. Seed Science and Technology 21(Suppl.) : 1B288.

ISTA. International Rules for Seed Testing. Ed. 2008/1, Pub. The ISTA, CH – 8303, Bassersdorf Switzerland.

Kalingrayar, A.S. & Dharmalingam, C. Influence of seed size on seed quality of sorghum. *Madras Agril. J.* 1980; 67 (7) : 453-461.

Kaya, M., Kaya, G., Kaya, M. D., Atak, M., Saglam, S.K., Khawar, M. and Ciftci, C. Y. Interaction between seed size and NaCl on germination and early seedling growth of some Turkish cultivars of chickpea (*Cicer arietinum* L.). J Zhejiang Univ Sci B. May 2008; 9(5): 371–377.

Keefe, P. Measurement of linseed (*Linum usitatissimum* L.) seed characters for distinctness, uniformity and stability testing using image analysis. *Plant Varieties and Seeds*, 1999 vol. 12, no. 2, Pp. 79-90.

Komba, C.G., Brunton, B.J. and Hampton, J.G. Effect of seed size within seed lots on seed quality in kale. Seed Science and Technology, Pub. International Seed Testing Association, Vol. 35, No. 1, 2007; Pp. 244-248(5).

Liu, Y., Van Der Burg, J., Aartse, J., Van Zwol, R., Jalink, H. and Bino, R. X-ray studies on changes in embryo and endosperm morphology during priming and imbibition of tomato seeds. *Seed Science Research*, vol. 3, no. 3, 1993; Pp. 171-178.

López-Castañeda, C., Richards, R., Farquhar, G. and Williamson, R. Seed and seedling characteristics contributing to variation in early vigor among temperate cereals. Crop Science, vol. 36, no. 5, 1996; Pp. 1257-1266.

Maranville, J. W. & Klegg, M. D. Influence of seed size and density on germination, seedling emergence and yield of grain sorghum. *Agron. J.* 1977; 69 (2): 329.

Marcroft, S.J., Potter, T.D., Salisbury, P.A., Burton, W.Z. and Ballinger, D.J. Proceedings of the 10th International Rapeseed Congress, 1999. Canberra, Australia, CD.

Mian, M.A. and Nafziger, E.D. Seed size and water potential effects on germination and seedling growth of winter wheat. *Crop Science*, vol. 34, no. 1, 1994; Pp. 169-171.

Murray, G.A., Swensen, J. B. and Auld, D. L. Influence of Seed Size and Planting Date on the Performance of Austrian Winter Field Peas. American Society of Agronomy, Agron. J. 1984; 76:595-598.

Nerson, H. Relationship between plant density and fruit and seed production in muskmelon. *Journal of American Society for Horticultural Science*, vol. 127, no. 5, 2002; Pp. 855-859.

Rohitha, B.H., Mott, J. and Hoffman, A. Effect of large seed size, post-sowing compaction and chemical seed dressings on the survival of canola seedlings in the presence of the earth mite damage. Proc. of the Aust. Agro. Conf., Australian Society of Agronomy, 2004.

Seiwa, C. and Kenji, D. Effects of seed size and emergence time on tree seedling establishment: importance of developmental constraints. *Oecologia*, vol. 123, no. 2, 2000; Pp. 208-215.

Soltani, A., Galeshi, S., Zeinali, E. and Latifi, N. Germination, seed reserve utilization and seedling growth of chickpea as affected by salinity and seed size. *Seed Science and Technology*, vol. 30, no. 1, 2002; Pp. 51-60.

Wood, D.C.P.C. Longden & Scoot, R.K. Seed size variation, its extent, source and significance in field crops. *Seed Sci. & Tech.* 1977; 5 : 337-352.
Woodstock, L. W. Progress report on the seed vigour testing. AOSA Newsletter, 1976: 59(2) : 1-78.
Khare, D. and Bhale, M. S. Seed Technology. Scientific publishers (India), Jodhpur, 2000.
Moebenburg, S. M. *Sabbal palmetto* seed size – causes of variation, choices of predators, and consequences for seedlings. Oecologia 1996; 106, 539-543.

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