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ORIGINAL ARTICLE

Effect of Seed Size on Seedling Vigour in Sunflower (*Helianthus annus* L.)

[1]Hossein Aliabadi Farahani, [2]Payam Moaveni and [1]Kasra Maroufi

[1]Member of Young Researchers Club, Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.
[2]Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.

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ABSTRACT

In order to determine the effect of seed size (small, medium and large) on seedling vigour in sunflower (*Helianthus annus* L.), an experiment was conducted in 2011 at Plant Physiology Laboratory, Islamic Azad University Shahr-e-Qods Branch by a completely randomized design with three replications and the first, seed viability was determined by Tetrazolium test method. The results showed that the effect of seed size was significant on germination percentage in $P \leq 0.01$. But he results showed that the effect of seed size was non-significant on seedling dry weight seedling vigour and seedling length. Mean comparison showed that the highest germination percentage (90.66 %), seedling dry weight (0.093 gr) and seedling vigour (8.43) were achieved came up to small seeds. But the highest seedling length (4.31 cm) were achieved came up to large seeds.

Key words: Seed size, seedling, seedling dry weight, seedling vigour and sunflower.

Introduction

Sunflower (*Helianthus annuus* L.) is a high yielding oilseed crop, but under scarce conditions, the yield is very lower than its real potential. Among the factors responsible for the low yield, imbalance use of fertilizers, improper plant protection, poor growth and sub optimum plant population are rather important. Suboptimum plant population generally results from poor and erratic germination. In recent years, a lot of studies have been done on invigoration of seeds to improve the germination rate and uniformity of growth and reduce the emergence time of many vegetables and some field crops [1]. For instance, large seeds may be favored because they produce larger and more vigorous seedlings with better chances of survival than small seeds [15,25,26,19]. Small seeds, however, may be ingested and dispersed more often [21], may be dispersed by a wider range of seed dispersers [27], and may be dispersed longer distances [32] compared to large seeds. On the other hand, because resources for producing seeds may be limited, small seeds are generally produced in great numbers than large ones [39]. Seed predators, either vertebrates or invertebrates, may be among the most important selection agents acting on seed size because they may choose large seeds that offer a better cost-benefit balance [18,8,25,2]. Whether variation in seed size and morphology separately affect population performance under different environmental conditions also remains unknown. Seedling establishment is arguably the most critical period in the life history of a plant. The factors that influence seed and seedling performance determine how many individuals will recruit into the population and ultimately reproduce. In arid environments, seedling establishment in perennial plants is highly variable and episodic [11,4,5]. In spite of the large number of studies, it remains unclear to what extent seed size and seed morphology independently affects ecological characteristics such as germination and seedling

Corresponding Author

Kasra Maroufi, Member of Young Researchers Club, Islamic Azad University, Shahr-e-Qods Branch, Tehran, Iran.
Email: kasramaroufi@yahoo.com

performance [46]. Seed size is an important seed quality characteristic affected by variety, environment and management practices [36]. The development of seeds in each whorl of the inflorescence occurs under varying environmental conditions causing variability in seed size and quality [29,44]. Therefore, seed size decreases from periphery to the center of the head. Robinson [35] found that large seeds produced more vigorous seedlings compared to small seeds while superiority of crops produced from large seeds was not determined on seed yield, hectoliter weight and oil percentage. Germination, survival and growth of seedlings are influenced largely by the food reserve in seeds, which increases with seed weight [41]. Conflicting reports exist on the interspecific variation in seed weight and germination behaviour. For instance, large seeds may germinate at higher percentages than small seeds [41], and small seeds may germinate at higher percentages than large seeds [22], or germination may be independent of seed size [35]. Similarly, Weimarck [43] reported that large seeds germinated better than medium and small seeds, and seedlings from large seeds had a higher survival rate than smaller seeds under field conditions. Moreover, seed size is positively correlated with seed vigour, and larger seeds tend to produce more vigorous seedlings [34]. This study was conducted to examine the Influence of seed size on seedling vigour in sunflower (*Helianthus annus L.*) seed's.

Materials and methods

In order to determine the effect of seed size (small, medium and large) on seedling vigour in sunflower seed's, an experiment was conducted in 2011 at Laboratory Sciences, Islamic Azad University Shahr-e-Qods Branch by a completely randomized design with three replications and the first, seed viability was determined by Tetrazolium test method. After disinfecting, seeds were put in disinfected Petri dish. Each Petri dish contained 100 seeds. Three replicates of 100 seeds were put between double layered rolled. The rolled paper with seeds was put into sealed plastic bags to avoid moisture loss. All of the Petri dish irrigated by distilled water. Seeds were allowed to germinate at 25 ± 1$^{\circ C}$ for 10 days. Germination percentage was recorded after the 10th day. Germination percentage was calculated with the following formula:

Germination percentage = Number of germinated seeds / Number of total seeds × 100

Also, Seedling vigour index was calculated by the following formula:

Seedling vigour = Germination percentage × Seedling dry weight

Statistical Analysis:

Data analyses were performed using the Spss statistical software (Version 16). Mean separations were performed by Duncan's multiple range test (DMRT) at 5% level.

Results and discusion

The results showed that the effect of seed size was significant on germination percentage in $P \leq 0.01$. The germination percentage decreased by increasing in seed size (Table1, Fig1). But he results showed that the effect of seed size was non-significant on seedling dry weight seedling vigour and seedling length. The highest seedling dry weight and seedling vigour were achieved by large seed (Table1, Fig 2,3). Also, the seedling length increased by increasing in seed size (Table1, Fig4). Seed size is the main factor determining germination percentage, as has frequently been reported for nondimorphic species [31,42]. Differences in germination percentage between dimorphic seeds reported in previous studies [17,7] may have resulted from differences in seed size rather than seed morphology. In addition to seed size, only seed head had a significant effect on germination percentage. Compared to small seeds, large seeds tend to have greater germination percentage within a population [14] and greater and more rapid emergence from deeper depths [4], in addition to producing seedlings that are initially larger. Smaller seeds, however, may gain an advantage over larger seeds by germinating faster [40] and having a greater relative growth rate [13]. However, we are aware of only one laboratory study [20] that showed a negative relationship between mean germination time and protein content in (*Hordeum vulgare* L.), but it did not relate protein content to seed size. To our knowledge, why larger seeds have higher germination rates than smaller seeds is mostly unknown, and this certainly applies to the larger morphs in dimorphic seeds. This is different from many other species, in which larger seeds produce larger seedlings [45,24]. Imbert *et al*. [16] found an effect of size only when seedlings were grown under competition. Seedlings of large and heavy seeds show better emergence, survival and growth than the seedlings of small seeds [3]. Therefore, the recommendation of Gamiely *et al*. [13] to use larger seeds to increase germination rate is not applicable to *Sorbus* seeds. This finding is in similarly with Galecic [9], who reported maximum germination in large size seed and was further confirmed by Moreno *et al* [28], who reported 31% more germination in large seeds as compared to small size seed. This finding is in similarity with Martinelli [29] who suggested that seed sizes and

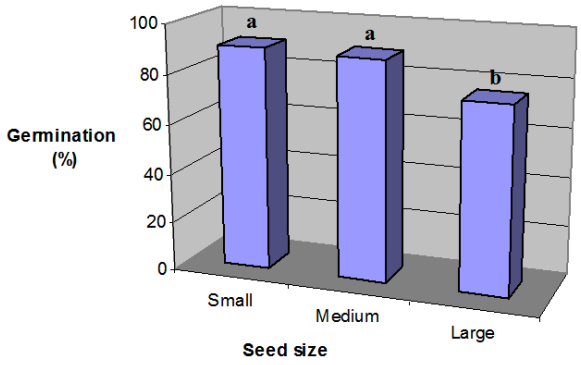

Fig. 1: Effect of seed size on germination percentage in sunflower.

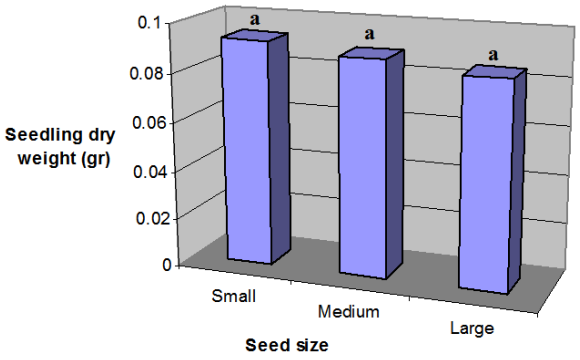

Fig. 2: Effect of seed size on seedling dry weight in sunflower.

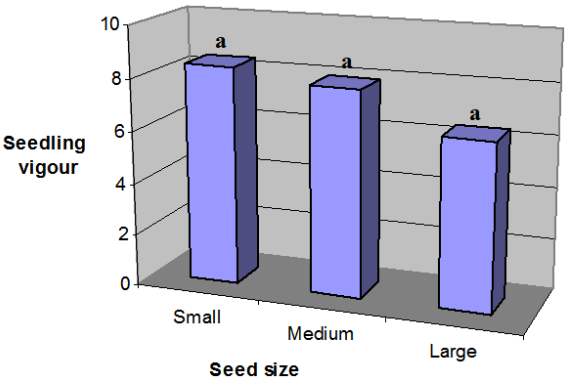

Fig. 3: Effect of seed size on seedling vigour in sunflower.

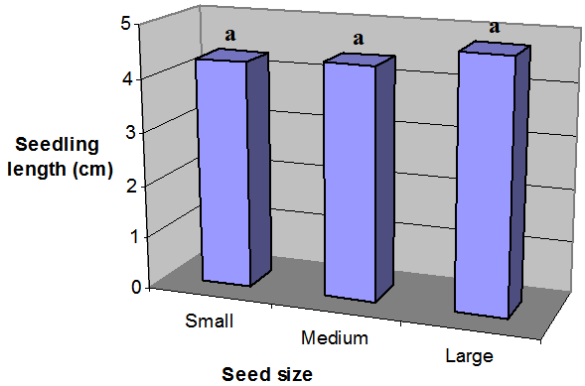

Fig. 4: Effect of seed size on seedling length in sunflower.

Table 1: Means Comparison

Treatment (seed size)	Germination percentage	Seedling dry weight(gr)	Seedling vigour	Seedling length (cm)
Small	90.66a	0.093a	8.43a	4.31a
Medium	89.33a	0.089a	7.95a	4.40a
Large	76b	0.085a	6.46a	4.76a

Means within the same column and factors, followed by the same letter are not significantly difference.

genotypes may compensate plants population. Position within the fruit has been shown to have a significant influence on seed size in legumes [38]. Seed size and early seedling vigor show conflicting trends in a variety of species. In some species, large seeds develop into more vigorous seedlings and adults [12,45]. On the other hand, in cocksfoot [37], barley [30], and *Rumex* spp. [6], there is no correlation between seed size and seedling growth when plants are grown in separate pots. In nature, where biotic and abiotic interactions are possible, the situation is more complex. There may be limitations and trade-offs to the production and effectiveness of large seeds, such as limited resources or space within a fruit, dispersal ability, or predator size preference.

Reference

1. Basra, S.M.A., M.N. Zia, T. Mehmood, I. Afzal, A. Khaliq, 2003. Comparision of different invigoration techniques in wheat *Triticum aestivum* L. seeds. Pak J Arid Agr., 5: 11-17.
2. Brewer, S.W., 2001. Predation and dispersal of large and smallseeds of a tropical palm. Oikos, 92: 245-255.
3. Bonfil, C., 1998. The effect of seed size, cotyledon reserves, and herbivory on seedling survival and growth in Quercus rugosa and Q. laurina (Fagaceae). Am J Bot., 85: 79-87.
4. Bowers, J.E., R.M. Turner, T.L. Burgess, 2004. Temporal and spatial patterns in emergence and early survival of perennial plants in the Sonoran Desert. Plant Ecol., 172: 107-119.
5. Chesson, P., R.L.E. Gebauer, S. Schwinning, N. Huntly, K. Wiegand, M.S.K. Ernest, A. Sher, A. Novoplansky, J.F. Weltzin, 2004. Resource pulses, species interactions, and diversity maintenance in arid and semi-arid environments. Oecologia, 141: 236-253.
6. Cidiyan, M.A., A.J.C. Mdlloch, 1982. Effects of seed size on the germination and competitive ability of *Rumex crispus* and *Rumex obtusifolia.* J. Eco., 70: 227-232.
7. El-keblawy, A., 2003. Effects of achene dimorphism on dormancy and progeny traits in the two ephemerals *Hedypnois cretica* and *Crepis aspera* (Asteraceae). Canadian Journal of Botany, 81: 550-559.
8. Ernst, W.H.O., D.J. Tolsma, J.E. Decelle, 1989. Predation of seeds of Acacia tortilis by insects. Oikos, 54: 294-300.
9. Galecic, J.S., 1993. Effects of calibrated seed on yield elements in some maize hybrids. *Review of Research Work at the Faculty of Agriculture, Belgrade*, 38: 19-28. *CAB Absts*. 1995, AN: 950713842.
10. Gamiely, S., D.A. Smittle, H.A. Mill, J.I. Banna, 1990. Onion seed size, weight, and elemental content affect germination and bulb yield. Horticulture Science, 25: 522-523.
11. Goldberg, D.E., R.M. Turner, 1986. Vegetation change and plant demography in permanent plots in the Sonoran Desert. Ecology, 67: 695-712.
12. Gross, K.L., J.D. Soule, 1981. Differences in biomass allocation to reproductive and vegetative structures of male and female plants of a dioecious, perennial herb, *Silene alba* (Miller) Krause. Amer. J. Bot., 68: 801-807.
13. Hendrix, S.D., E. Nielsen, T. Nielsen, M. Schutt, 1991. Are seedlings from small seeds always inferior to seedlings from large seeds? Effects of 1032 International journal of plant sciences.seed biomass on seedling growth in Pastinaca sativa L. New Phytol., 119: 299-305.
14. Hendrix, S.D., E.J. Trapp, 1992. Population demography of Pastinaca sativa (Apiaceae): effects of seed mass on emergence, survival, and recruitment. Am J Bot., 79: 365-375.
15. Howe, H.F., W.M. Richter, 1982. Effects of seed size on seedling size in Virola surinamensis: a within and between tree analysis. Oecologia, 53: 347-351.
16. Imbert, E., J. Escarre, J. Lepart, 1997. Seed heteromorphism in *Crepis sancta* (Asteraceae): performance of two morphologies in different environments. Oikos, 79: 325-332.
17. Imbert, E., 1990. The effects of achene dimorphism on the dispersal in time and space in *Crepis sancta* (Asteraceae). Canadian Journal of Botany, 77: 508-513.
18. Janzen, D.H., 1969. Seed eaters versus seed size, number, toxicity and dispersal. Evolution, 23: 1-27.
19. Khan, M.L., 2004. Effects of seed size and seedling success in Artocarpus heterophyllus L., a tropical tree species of northeast India. Acta Oecol., 25: 103-110.
20. Kristensen, L., 2003. Maternal effects due to organic and conventional growing conditions in spring barley (*Hordeum vulgare*). Biological Agriculture and Horticulture, 21: 195-208.
21. Levey, D.J., 1987. Seed size and fruit-handling techniques of avian frugivores. Am. Nat., 129: 471-485.

22. Marshall, D.L., 1986. Effect of seed size on seedling success in three species of Sesbania (Fabaceae). Am J Bot., 73: 457-464.
23. Martinelli, A., N.M. Carvalho, N.M. Carvalho, 1999. Seed size and genotype effects on maize (*Zea mays* L.) yield under different technology levels. Seed Sci. Technol., 27: 999-1006.
24. Maxwell, C.D., A. Zobel, D. Woodfine, 1994. Somatic polymorphism in the achenes of *Tragopogon dubius*. Canadian Journal of Botany, 72: 1282-1288.
25. Moegenburg, S.M., 1996. Sabal palmetto seed size: causes of variation, choices of predators, and consequences for seedlings. Oecologia, 106: 539-543.
26. Moles, A.T., M. Westoby, 2004. Seedling survival and seed size: a synthesis of the literature. J. Ecol., 92: 372-383.
27. Moermond, T.C., J. Denslow, 1985. Neotropical avian frugivores: patterns of behavior, morphology and nutrition, with consequences for fruit selection. Ornithol. Monogr, 36: 865-897.
28. Moreno, M.E., B.M.E. Vazquez, A. Rivera, R. Navarrete, V.F. Esquivel, 1998. Effect of seed shape and size on germination of corn (*Zea mays* L.) stored under adverse conditions. Seed Sci. Technol., 26: 439-48. *CAB Absts*. 1999, AN: 990701435.
29. Munshi, S.H., B. Kaushal, R.K. Bajaj, 2003. Compositional changes in seeds influenced by their positions in different whorls of mature sunflower head. J. Sci. Food Agr., 83: 1622-1626.
30. Naylor, R.E.L., 1976. Changes in the structure of plant populations. J. App. Eco., 13: 513-521.
31. Parciak, W., 2002. Environmental variation in seed number, size and dispersal of a fleshy-fruited plant. Ecology, 83: 780-793.
32. Pizo, M.A., I. Simao, 2001. Seed deposition patterns and the survival of seeds and seedlings of the palm Euterpe edulis. Acta Oecol., 22: 229-233.
33. Perez-Garcia, F., J.M. Iriondo, J.B. Martinez-Laborde, 1995. Germination behaviour in seeds of Diplotaxis erucoides and D. virgata. Weed Res., 35: 495-502.
34. Ries, S.K., E.H. Everson, 1973. Protein content and seed size relationships with seedling vigour of wheat cultivars. Agron. J., 65: 884-886.
35. Robinson, R.G., 1974. Sunflower performance relative to size and weight of achenes planted. Crop Sci., 14: 616-618.
36. Robinson, R.G., 1978. Production and Culture. In: Sunflower Science and Technology. (Ed. J.F. Carter). Wisconsin, USA, pp: 89-132.
37. Ross, M.A., J.L. Harper, 1972. Occupation of biological space during seedling establishment. J. Eco., 60: 77-88.
38. Schaal, B.A., 1980. Reproductive capacity and seed size in *Lupinus texensis.* Amer. J. Bot., 67: 703-709.
39. Smith, C.C., S.D. Fretwell, 1974. The optimal balance between size and number of offspring. Am. Nat., 108: 499-506.
40. Susko, D.J., L. Lovett-Doust, 2000. Patterns of seed mass variation and their effects on seedling traits in Alliaria petiolata. Am J Bot., 87: 56-66.
41. Tripathi, R.S., M.L. Khan, 1990. Effects of seed weight and microsite characteristics on germination and seedling fitness in two species of Quercus in a subtropical wet hill forest. Oikos, 57: 289-296.
42. Vaughton, G., M. Ramsey, 1998. Sources and consequences of seed mass variation in *Banksia marginata* (Proteaceae). Journal of Ecology, 86: 563-573.
43. Weimarck, A., 1975. Kernel size and frequency of euploids in octoploid triticale. Hereditas, 80: 69-72.
44. Weiss, E.A., 1983. Oilseed Crops. Longman Inc., New York, pp: 402-462.
45. Weis, I.M., 1982. The effects of propagule size in germination and seedling growth in *Mirabilis hirsuta.* Can. J. Bot., 60: 1868-1874.
46. Zhang, J.H., 1993. Seed dimorphism in relation to germination and growth of *Cakile Edentula*. Canadian Journal of Botany, 71: 1231–1235.