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EFFECTS OF SEED DETERIORATION AND INOCULATION WITH *Mesorhizobium ciceri* ON CHICKPEA PLANT PERFORMANCE UNDER LABORATORY CONDITIONS

Abbas BIABAN[1], Lynne Carpenter BOGGS[2], Hosein SABOURY[1]

[1]Gonbadekavoos University, Department of Crop Production, Iran
[2]Washington State University, Center for Sustaining Agriculture and Natural Resources, USA

Corresponding author email: abs346@yahoo.com

Abstract

Deterioration of seeds during storage can cause significant declines in seedling vigor and crop yield, particularly in less developed regions. This project compared seedling vigor and field performance of two chickpea (Cicer arietinum) cultivars (Arman and Hashem), subjected to 0 (control), 7, 14, 21 and 28 days of deterioration (DOD) in 40°C storage. Percent seed germination, radical length, seedling length, root weight and seedling weight were recorded. Seeds of both varieties declined in germination and growth with increasing deterioration. Seed germination and growth declined with increasing storage, and germination was zero after 21 or 28, DOD.

Key words*: Chickpea, Deterioration, Germination.*

INTRODUCTION

Cicer is one of the most important pulse crops, providing high quality protein for human nutrition. Cicer is suitable for regions with warm weather and semi-dry conditions. Cicer is also cold tolerant, surviving to -9ºC. In most regions cicer is planted in spring but in warmer regions it is planted in autumn. Seed is the basic agricultural input, and access to preferred and adapted seed is a prerequisite for sustainable production.

Formal seed systems produce and diffuse modern varieties and certified seed, but there is growing research and policy interest in informal seed systems, as informal channels provide 80-90% of the materials farmers sow in their fields worldwide (Cooper, 1993). During seed storage between field seasons, seed stocks can suffer deterioration due to heat, humidity, and biotic agents. In 2008, 92% of the world's chickpeas were produced in developing countries (FAO, 2009; IMF, 2010).

Storage of seed in developing areas is often less than ideal, and deterioration of seed can be significant.

Sustainable mechanisms to improve seed storage and reduce the impact of seed deterioration on yield are needed to improve global food security.

Seed deterioration can be defined as the loss of quality, viability and vigor either due to aging or effect of adverse environmental factors.

The rates of deterioration rapidly increase with increase in either seed moisture content or temperature of storage (Ellis et al., 1985). The use of healthy seeds may lead to an increase of yield for two reasons. The percentage emergence of healthy seeds is greater than that of weaker seeds.

Therefore, healthy seed may provide a higher crop density than deteriorated seed even when conditions are not ideal.

The subsequent plant growth rate is also greater in plants that have originated from healthy seed.

MATERIALS AND METHODS

This study was carried out in both laboratory and field. In the lab experiment seeds of Hashem and Arman were treated to deteriorate during 0, 7, 14, 21 and 28 days at 40ºC. Groups of seeds were placed in mesh bags.

Every bag was placed on a sieve suspended within a closed container above water.

The bags did not contact the water at any point, but seeds could absorb the humidity in the dish.

After treatment the seeds were placed between 2 sheets of moist germination paper for testing

germination. The paper was rolled and tied it in place with a rubber band. Rolls containing seeds were placed in plastic bags and put into the germination box at 20º C and 70% humidity for 10 days. Seed germination percentage, radicle and seedling length, radicle and seedling weight were determined

Data were analyzed using SAS (SAS Institute, 1990). Effects were considered significant at P values $\leq$ 0.05. Duncan multiple range tests were conducted for mean comparison.

RESULTS AND DISCUSSIONS

Treatments of cultivar, deterioration and interaction between them had a significant effect on germination percent, cotyledon length, cotyledon weight, radicle length, and radicle weight (Table 1). The control (non-deteriorated seeds) performed best in all germination and seedling characteristics (Table 2). Seeds of both varieties declined in germination and growth with increasing deterioration. After 21 or 28 DOD no seeds germinated (data not shown). Seven and 14 DOD reduced germination on average by 57% and 80%, respectively. After 14 DOD only radicles were present on 10-day old germinated seedlings.

Seedlings of Hashem cultivar generally performed better than Arman (Table 2). In non-deteriorated seed Hashem produced more cotyledon length and radicle length and weight than Arman. After 7 DOD germinated Hashem seed produced more cotyledon length and weight than Arman, but less radicle weight. Response to 14 DOD was similar in both cultivars.

Table1- Analysis of variance of germination percent, cotyledon length and weight, radicle length and weight of Hashem and Arman chickpeas varieties after 0, 7, or 14 days storage at 40°C.

Sources of Variation	Degrees of freedom	Mean squares				
		Germination percent	Cotyledon length	Cotyledon weight	Radicle length	Radicle weight
Cultivar (C)	1	133**	6.1**	0.0007*	3.5**	0.0001**
Deterioration (D)	2	1221**	7.1**	0.025**	25**	0.02**
C × D	2	49**	1.6**	0.0001*	1.9**	0.004**
Error	12	10.6	0.03	0.00008	0.19	0.00007
Coefficient of Variation		6.6	17.6	11.3	12.2	12.7

*, ** significant at the 0.05 and 0.01 probability levels, respectively.

Table 2 - Means of germination percent, cotyledon length and weight, radicle length and weight of Hashem and Arman chickpeas varieties after 0, 7, or 14 days storage at 40°C.

Cultivar	Deterioration (days)	Germination (%)	Cotyledon length (cm)	Cotyledon weight (g)	Radicle length (cm)	Radicle weight (g)
Hashem	0	100 a	3.1 a	0.14 a	6.2 a	0.16 a
	7	42 b	1.8 b	0.10 b	2.7 c	0.02 d
	14	19 c	0.0 d	0.0 d	1.1 d	0.03 d
Arman	0	100 a	1.3 c	0.12 a	4.0 b	0.10 b
	7	43 b	0.14 d	0.08 c	2.2 c	0.07 c
	14	21 c	0.0 d	0.0 d	1.1 d	0.02 d

Values within the same column followed by the same letters are not significantly different according to Duncan's multiple range test (P =0 .05).

CONCLUSIONS

Sustaining and increasing production of high quality protein foods for the growing human population will require efficient use of resources in both ideal and non-ideal conditions. High seed quality should be maintained to minimize the quantity of seed and other resources needed for planting and production. However, given that many regions do not have ideal seed storage facilities, information is needed about crop varieties that maintain seed health in deteriorating conditions, as well as potential seed treatments

to counteract deterioration. In this study we found that Hashem variety cultivar had not only good field performance by non-deteriorated seed, but substantial resilience to seed deteriorating conditions. Inoculation of chickpea seeds with M. ciceri provided the greatest benefit to non-deteriorated Hashem seed, but also provided moderate remediation of deterioration treatments. Increased use of varieties that with stand non-ideal seed storage conditions, and consistent use of proper rhizobial inoculants, should be recommended particularly for regions without ideal storage facilities.

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