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Effect of NPK Fertilization on the Mechanical Damage to Chickpea Seeds

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Abstract. *The aim of research was to determine the effect of nitrogen (N), phosphorus (P) and potassium (K) fertilizers on the mechanical damage to chickpea seeds under impact. The martial for tests was from a field experiment with varied levels fertilization with nitrogen (0 and 50 kg/ha, N), phosphorus (0 and 100 kg/ha, P_2O_5) and potassium (0 and 100 kg/ha, K_2O). The variation of the mechanical damage was analyzed depending on the mode of varied fertilization, seed moisture content and impact energy. It was shown that varied fertilizer dose, moisture content and impact energy significantly influenced mechanical damage to chickpea seeds at the 1% probability level ($P<0.01$). Resistance to the breakage of chickpea seeds increased with increase in the phosphorus and potassium fertilizers dose. Seeds from the plot with a fertilization dose: 0/0/100 kg/ha of N/P/K, exhibited the highest resistance to damage. As the moisture content of the seeds increased from 8.5 to 20%, the amount of the percentage breakage of seeds decreased from 35.72 to 18.54%. Increasing the impact energy from 0.1 to 0.3 J caused an increase in the percentage breakage of seeds from 8.441 to 41.198%.*

Keywords: Chickpea, mechanical damage, harvesting, handling, fertilization.

Introduction

Chickpea (*Cicer arietnum* L.), seeds are subjected to a series of static and dynamic loads during harvesting, handling, processing, and storage. Such loadings cause external and internal damage in seeds, which lead to decreases in quality and can eliminate both viability and vigor (Shahbazi, 2011). The harvesting and the postharvest operations negatively influenced the seeds quality. The machinery and equipment for harvesting, transporting, storage and processing caused significant mechanical damage to seeds i.e. skin rupture, seed fracture etc. The damage resulted from mechanical interaction between biological material (seeds) and machineries material (steel, rubber etc.). Most authors admit that the seeds damage mainly occurs in the course of harvest and transport, where the seeds are damaged by impact forces.

The mechanical resistance to the impact damage of seeds among other mechanical and physical properties plays a very important role in the design and operational parameters of equipment relating to harvesting, threshing, handling and other processing of the seeds (Baryeh, 2002). It is very important to use injury minimizing cropping and harvesting techniques and to further introduce varieties and agro technical methods that ensure the maximum resistance to injury (Niewczas, 1994). Resistance to impacts can be advantageous (storage, biological form). On the other hand, high impact resistance is an unfavorable trait in processing because of higher energy costs and less efficiency in size reduction (Szwed and Tys, 2002).

Among biological, physical and thermal factors, an important role in the resistance to damage is played by seed hardness and resilience. The higher resilience, the better resistance to damage and therefore higher their sowing value/potential. Particularly important here are the seed cover, its structure, position and chemical composition (Gorzelany, 1999). These factors are affected by the mineral fertilization level (Szwed and Tys, 2002). Therefore, it is useful to determine the effects of various modes of fertilization of chickpea seed plantation on the mechanical damage of seeds. Another highly important factor that has a significant effect on the resistance to damage of seeds is their water (moisture) content. Water content in seeds affects their anatomical-morphological structure only to slight degree (Dziki and Laskowski, 2007), but plays a significant role in affecting their elastic properties. Dry biological material is little elastic and relatively brittle, and stress caused by external forces is more likely to disturb its inner structure. Higher moisture content increases the elasticity and deformability of seeds. There were some research approved a significant influence of moisture content upon the seed damage and affirm that the damage increases significantly as the moisture content decreases (Baryeh, 2002; Parde *et al*., 2002; Szwed and Lukaszuk 2007; Shahbazi ,2011). According to numerous studies, there is an optimum water content for each variety in which a seed is least vulnerable to injuries from outer mechanical loads (Niewczas, 1994). This feature may be important in the case of selecting the time of harvest and postharvest process, from the viewpoint of minimizing yield losses due to the share of damaged seeds.

Impact damage to seeds has been the subject of much research due to the loss in product quality incurred during harvesting, handling and processing. Many studies have been conducted to determine the mechanical damage to seeds, such as: Kim *et al*. (2002) on maize, Parde *et al*. (2002) on soybean seed, Sosnowski (2006) on bean seed, Szwed and Lukaszuk (2007) on rapeseed and wheat kernels, Khazaei *et al*. (2008) on wheat seed, Khazaei (2009) on white kindey bean, Shahbazi (2011) on chickpea seed, Shahbazi *et al*. (2011a) on pinto bean, Shahbazi *et al*. (2011b) on navy bean and Shahbazi (2012) on wheat seed.

There is little information in the published literature investigating the effects of nitrogen, phosphorus and potassium fertilizers rate on seed physical properties and resistance to impact of chickpea. Therefore, the objective of this study was to investigate the effects of various