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Effect of planting pattern (row spacing and seed spacing in row) on some pea physical properties (*Pisum sativum* var. Pofaki)

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Abstract

In this study, peas were planted according to the map. Product management was done completely from planting to mature period and harvest time. Plant to plant distance in row, was determined 5, 7 and 9 cm and row distance was selected 30, 40 and 50 cm. For measuring pea dimensions, 15 peas were selected randomly from pods. All process was repeated three times for all levels and data were analyzed by using of completely randomized design (CRD) and SAS software. The effect of seed spacing in row was significant on length, width, geometric diameter, arithmetic diameter, cross sectional area, mass, actual volume and bulk volume at the level of 5% ($P<5\%$) and thickness at the level of 1% ($P<1\%$). But it was not significant on lateral surface and sphericity ratio. Also the effect of row distance and interaction effect of seed spacing in row and row distance were not significant in any case.

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Introduction

As the supplier of protein, cereals have high food value and comprise main part from food people. With scientific name of *Pisum Satium*, pea is from *Leguminosae* family and is a proper plant for cold climates and relatively humid. Its winter planting is desirable in tropical regions. In world scale, pea has the second of importance rank among cereals after bean (Summerfield & Robert, 1985). In the regions which cereals are cultivated in form of homebred and average annual precipitation is 300 mm, pea is a good plant for cultivating alternately with other cereals. Pea is consumed both dry form and green form (Hosseini, 1994; Summerfield, 1985).

Accessing to scientific information in relationship with the physical properties of pea seed is important for the optimal design of storage equipment, transportation, winnowing, processing and packing. Shape, size, volume, cross sectional area, density, porosity and color are the physical properties that have importance in many issues related to the design of processing machineries or product behavior analysis during transportation. The importance of porosity amount of grains arises during storage, packing and determining stability of the grain mass against air. Shape and physical dimensions are important for measuring, classifying, screening and other separation processes (Mohsenin, 1978).

For preparing as foodstuff, agricultural products are borne one or more processes. Whether these processes are easy such as cleaning, separating and transmitting or theses processes are transformative or complementary, in turn, product properties will be changed. So understanding mechanical and physical properties of product and the manner of their change and maintenance in direction of desirable goals can has significant effect on maintaining quality and quantity of final product. On the other hand, building and designing machines and needed equipment for harvesting, transporting, storing and packing of agricultural products is impossible without having their different parameters. So knowing different properties of agricultural products is needed and important for reducing wastes, increasing product quality, harvesting and processing after harvest (Mohsenin, 1978; Bern and Charity, 1975).

Density is needed for designing the machines related to processing and storing including dryers and grain silos. Porosity has effect on airflow between seeds in pea mass. Designing related machines regardless these properties will has weak results. In the theories that are used for anticipating warehouse space, bulk density considers as main factor (Lvin, 1970). Therefore, the determination and attention to these properties is an important principle (Aydin, 2003).

Biabani (2008) has studied the effect of row and plant distance on performance of pea (*Pisum Sativum var. Shamshiri*). Some studies about measuring physical properties of pea seed were down, consist of: Baryeh and Mangope (2002) studied some physical properties of *QP-38* variety pigeon pea, Paksu *et al.* (2006) determined some mechanical and physical properties of pea grains.

Unfortunately, few studies have been conducted about the effect of planting pattern on physical properties. So researches on planting pattern can be helped to understand the physical properties of agricultural products, such as pea and etc. and it is effective in obtaining high yields.

The aim of this study is to survey the effect of planting pattern on some physical properties of pea grains (*Pisum Sativum var. Pofaki*).

Material and methods

In this study, pea was planted in Research Station of Gorgan university of Agricultural Sciences and Natural Resources in November according to map. Product management was done completely from planting to mature period and harvest time. Plant to plant distance in row, was determined 5, 7 and 9 cm and row distance was selected 30, 40 and 50 cm. Soil moisture content was determined 32 (w.b.%) in planting time and from silt clay type. All process was repeated three times for all levels and data were analyzed by using of completely randomized design (CRD) and SAS software.

Measurement of Moisture content

After the pods in bright and green pea had been filed with fresh and smooth seeds, with removing lateral rows, four pods were picked up randomly by hand and from each treatment 15 pea were selected randomly from four pods. For calculating initial moisture, samples were kept in an oven with temperature of 72 °C within 24 hours. Pea moisture content was measured by weight percent (Equ. 1) according to ASAE standard (ASAE, 1997). Initial moisture content equaled to 70 (w.b.%).

$$W = \frac{(m_1 - m_2)}{m_1} \times 100 \quad (1)$$

Where, m_1 is initial weight of pea; m_2 is pea weight after drying with oven and W is weight percent of pea moisture (w.b.%).

Measurement of Dimensions and Mass

For measuring pea dimensions, 15 pea were selected randomly from four pods. 3 main dimensions of any pea, length, width and height were measured by digital caliper with accuracy of 0.02 mm. For measuring mass, it was used digital scale EK-600i model made in Japan, with accuracy of 0.01 g. These tests were repeated 10 times.

Determination of Geometric Properties

Using axial dimensions of pea, geometric properties, length, width, thickness, geometric diameter, arithmetic diameter, lateral surface, sphericity ratio and cross sectional area were calculated respectively by following equations (Dursun and Dursun, 2005; Mohsenin, 1978; McCabe *et al.*, 1986):

$$D_a = {(L + W + T)}/{3} \quad (2)$$

$$D_g = \sqrt[3]{(LWT)} \quad (3)$$

$$S = \pi D_g^2 \quad (4)$$

$$\emptyset = \frac{\sqrt[3]{LWT}}{L} \times 100 \quad (5)$$

$$S_p = \frac{\pi D_g^2}{4} \quad (6)$$

Determination of Gravity Properties

At first, the weight of 15 pea was earned by scale. For measuring volume, liquid displacement method was used along scaled burette in terms of mm. At first, 15 pea were placed by a cone-like funnel (with cross-section of radius 3 cm and height 4 cm) into water in a scaled cylinder (with volume of 250 ml with diameter of 6 cm and height 10 cm). Mass volume was calculated with water displacement amount in 3 times for each treatment.

Pea actual volume was calculated using liquid displacement principle. One of the liquid displacement methods for determining the actual volume of per sample is plateform scale method (Mohsenin, 1978). In this method, volume was estimated in terms of cube millimeter based on following equation:

$$V_p = \frac{Mdt}{\rho_t} \quad (7)$$

In this equation, V_p is the volume of a pea seed (mm^3), M_{dt} is displaced liquid weight and pea volume too and ρ_t is liquid density.

The density of pea grain mass is calculated from equation 8 and particle density from equation 9 (Baryeh, 2001b; Suthar, and Das, 1996):

$$\rho_b = \frac{M}{(V_2 - V_1)} \quad (8)$$

Where:

ρ_b is bulk density (g/mm^3), M is mass of 15 pea, V_1 and V_2 are primary and secondary read volumes from burette (mm^3), respectively.

$$\rho_p = \frac{M}{V_p} \quad (9)$$

Where:

ρ_p is particle density (g/mm^3) and V_p is volume of a pea grain (mm^3).

And equivalent diameter for each pea is calculated from equation (10) by estimating average actual volume based on following equation (Baryeh, 2001b; Suthar, and Das, 1996):

$$D_e = \sqrt[3]{\frac{6V}{\pi}} \quad (10)$$

Porosity is defined as occupied space percentage by air particles among seeds. It is calculated using equation 11 (Mohsinin, 1978):

$$\varepsilon = \left[1 - \frac{\rho_b}{\rho_p}\right] \times 100 \qquad (11)$$

Where:

ε is porosity based on percentage, ρ_b, bulk density (g/mm3) and ρ_p is particle density (g/mm3).

Results and discussion

Geometric Properties

Table 1 shows the results of variance analysis of seed spacing in row and row distance on geometric properties. The effect of seed spacing in row is significant on length, width, geometric diameter, arithmetic diameter and cross sectional area in level of 5 percent (P<5%) and thickness in level of 1 percent (P<1%). But it is not significant on lateral surface and sphericity ratio. Also the effect of row distance and interaction effect of seed spacing in row and row distance are not significant in any case.

Table 1. Variance analysis of seed spacing in row and row distance on geometric properties.

	Mean square							
Source of variation	L	W	T	Gd	Ad	Ls	Csa	Sr
SSR	2.41*	1.65*	2.24**	2.08*	2.07*	9930 ns	574.34*	1.62 ns
Rd	0.184 ns	0.2 ns	0.06 ns	0.13 ns	0.13 ns	7417.44 ns	51.87 ns	1.58 ns
SSR ×Rd	0.46 ns	0.29 ns	0.39 ns	0.35 ns	0.36 ns	2825.02 ns	96.69 ns	0.91 ns

** and *Significant in statistic level of 1 and 5%, and ns not significant.

L= Length, W=Width, T=Thickness, Gd= Geometric diameter, Ad=Arithmetic diameter, Ls=Lateral surface, Csa= Cross sectional area, Sr=Sphericity ratio, PPR =Seed spacing in row, Rd=Row distance.

Figures 1 and 2 were drawn to show the effect of seed spacing in row on length, width, thickness, geometric diameter, arithmetic diameter and cross sectional area. As can be seen from Fig. 1, with increasing seed spacing in row, cited geometric values have been increased in all geometric properties. Also as can be seen from Fig.2 with increasing seed spacing in row, cross sectional area will increase.

Table 2. Variance analysis of row distance and seed distance on gravity properties.

	Mean square					
Source of variation	M	Av	Bv	Ad	Bd	P
SS	15.37*	18370370*	31259259*	5.93 ns	1.4 ns	16.56 ns
Rd	1.68 ns	1370370 ns	1037037 ns	2.25 ns	3.9 ns	19.05 ns
SSR ×Rd	3.29 ns	2370370 ns	18814814 ns	8.68 ns	2.95 ns	51.65 ns

*Significant in statistic level of 5%, and ns not significant.

M= Mass, Av=Actual volume , Bv=Bulk volume, Ad=Actual density , Bd=Bulk density, P= porosity, PPR =Seed spacing in row, Rd=Row distance.

In distance of 10 cm for any pea, the highest values of length, width, thickness, geometric diameter and arithmetic diameter equaled to 12.36, 10.64, 10.9, 11.27, and 11.3 mm, respectively.

Other researchers studied geometric properties in fruit types such as millet (Baryeh, 2002a), faba bean (Altuntas and Yildiz, 2007), amarnath seeds (Abalone, 2004) , pine (Ozguven and Vursavus, 2005), wild plum (Calisir, *et al.* 2005), Pistachio

(Pistacia vera L.) nut and its Kernel (Kashaninejad, 2006).

Gravity Properties

Table 2 shows variance analysis results of pea and row distance on gravity properties. The effect of seed spacing in row is significant on mass, actual volume and bulk volume in level of 5 percent(Pr<5%). But it is not significant on actual density, bulk density and porosity. The effect of row distance and also the interaction effects of seed spacing in row and row distance are not significant in any case.

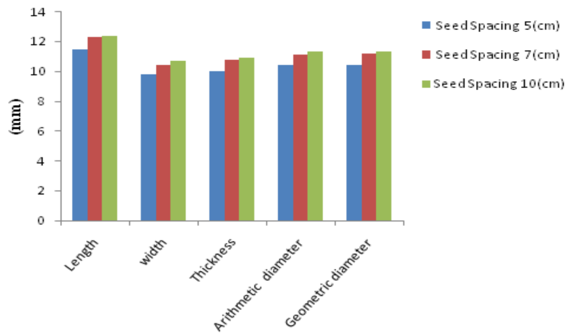

Fig. 1. Effect of seed spacing in row on length, width, thickness, geometric diameter, arithmetic diameter.

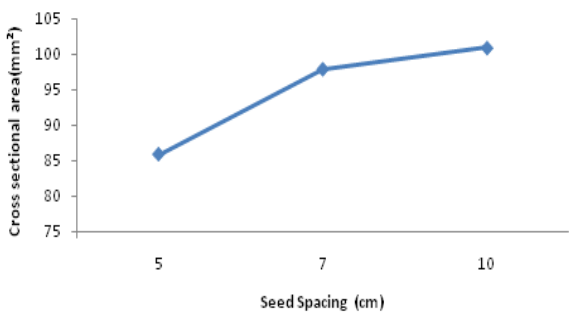

Fig. 2. Effect of seed spacing in row on cross sectional area.

Figure 3 was drawn to show the seed distance on actual volume and bulk volume. As can be seen from Fig. 3, with increasing seed distance, the amounts of actual volume and bulk volume will increase. Also as can be seen from Fig. 4, with increasing seed distance, unit mass will enhance.

In the seed with distance of 10 cm, the maximum values of actual volume and bulk volume are 13000 and 19778 mm^3 and also the maximum value of unit mass was calculated 12.63 gr. Gravity properties were surveyed for some seeds including Bambara groundnuts (Baryeh, 2001b), green gram (Nimkar, and Chattopadhyay, 2001), white lupin (Ogut, 1998), soybean (Deshpande, *et al.*, 1993), cherry laurel (Calisir and Aydin, 2004), pistachio nut and its kernel (Razavi, 2007).

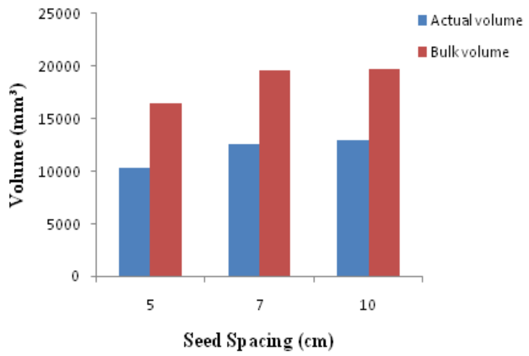

Fig. 3. Effect of seed distance on actual volume and bulk volume.

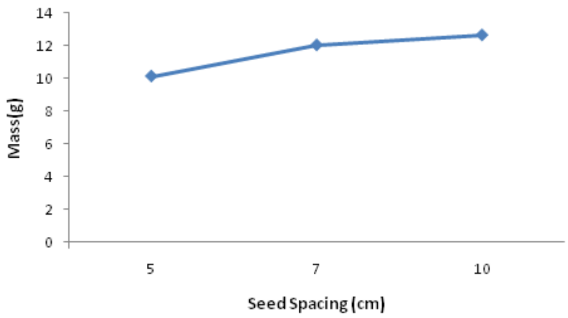

Fig. 4. Effect of seed distance on unit mass.

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