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Evaluation and Management of the grain of ten pea lines (Pisum sativum L.) in cultivable valleys

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Abstract. Introduction: The evaluation and management of the grain of ten varieties or lines of pea (Pisum sativum L.) in cultivated valleys, implies knowing the yield and pod width of pea. **Objective:** To evaluate the yield (quantity of grains per area of land) and the pod width of pea (Pisum sativum L.). **Methodology:** The research was carried out at the Donoso agricultural experimental station, located in Huaral, Peru. Complete randomized block designs (DBCA) were used, with 10 treatments, including 8 lines obtained from the cross between the parents. For the analysis of the data, the Infostat program and the Tukey test with $\alpha = 0.05$ were used. **Results:** Lines 7 and 3 had a higher yield, higher than 9,100 kg/ha. **Conclusion:** Lines Line 7, Line 3, have a higher yield; Regarding the width of the pea pod (in cm) they were all similar.
Keywords: Evaluation, management, varieties, pea, Pisum sativum L., valleys, cultivable.

Evaluación y Gestión del grano de diez líneas de *arveja* (*Pisum sativum L.*) en valles cultivables

Resumen. Introducción: La evaluación y gestión del grano de diez variedades o líneas de arveja (Pisum sativum L.) en valles de cultivo, implica conocer el rendimiento y ancho de vaina de arveja. **Objetivo:** Evaluar el rendimiento (cantidad de granos por área de terreno) y el ancho de vaina de la arveja (Pisum sativum L.). **Metodología:** La investigación se llevó a cabo en la estación experimental agraria Donoso, ubicada en Huaral, Perú. Se utilizaron diseños de bloques completos al azar (DBCA), con 10 tratamientos, incluyendo 8 líneas obtenidas del cruce entre los parentales. Para el análisis de los datos se empleó el Programa Infostat y la prueba de Tukey con $\alpha = 0,05$. **Resultados:** Las líneas 7 y 3 tuvieron mayor rendimiento, superiores a 9,100 kg/ha. **Conclusión:** Las líneas Línea 7, Línea 3, son de mayor rendimiento; con respecto al ancho de vaina de la arveja (en cm) todas fueron similares.
Palabras clave: Evaluación, gestión, variedades, arveja, Pisum sativum L., valles, cultivables.

Avaliação e Gestão do Grão de Dez Linhagens de Ervilha (Pisum sativum L.) em Vales Cultiváveis

Resumo. Introdução: A avaliação e gestão do grão de dez variedades ou linhagens de ervilha (Pisum sativum L.) em vales de cultivo envolve conhecer o rendimento e a largura da vagem da ervilha. **Objetivo:** Avaliar o rendimento (quantidade de grãos por área de terreno) e a largura da vagem da ervilha (Pisum sativum L.). **Metodologia:** A pesquisa foi realizada na estação experimental agrícola Donoso, localizada em Huaral, Peru. Foram utilizados desenhos de blocos completos ao acaso (DBCA), com 10 tratamentos, incluindo 8 linhagens obtidas pelo cruzamento dos parentais. Para a análise dos dados, foi utilizado o Programa Infostat e o teste de Tukey com $\alpha = 0,05$. **Resultados:** As linhagens 7 e 3 apresentaram maior rendimento, superiores a 9.100 kg/ha. **Conclusão:** As linhagens Linhagem 7 e Linhagem 3 são de maior rendimento; em relação à largura da vagem da ervilha (em cm), todas foram semelhantes.
Palavras-chave: Avaliação, gestão, variedades, ervilha, Pisum sativum L., vales, cultiváveis.

I. Introduction

The pea (*Pisum sativum* L.) is a legume plant widely adapted to the conditions of the mountains and the Peruvian coast. In 2010, the harvested area of green pea grain was 33,255 hectares and 50,582 hectares for dry grain, with an average national yield of green pea grain of 3,381 kg/ha, and dry grain of 1,013 kg/ha (Camarena et al, 2014). The pea is an important legume in the diet of our country and the world, since it is an excellent source of proteins, fiber, carbohydrates, vitamins and minerals. In addition to these properties mentioned, the pea has a low sodium, cholesterol and gluten-free content. What allows it to be consumed by diabetics is an important characteristic of its high content of diabetic fiber (Bolaños, 2001).

Anchivilca, (2018), in his thesis entitled "Organic manure and Npk fertilization in green pea (Pisum sativum L.) cv. Rondo, under drip irrigation in Tupicocha, Huarochirí" mentions (OEEE-MINAGRI, 2014). That, in 2014, the harvested area was 80,340 ha, of this total 49,397 ha corresponds to the harvested area of dry grain and 34,943 Ha for green grain with an average yield of 1,140 kg/ha and 3,820 kg/ha, respectively. The department of Arequipa stands out for its highest yield in green grain with 8,450 kg/ha.

Among the limiting factors of pea production in green pod and dry pod is the shortage of certified seeds of varieties adapted to the Andean area, since it results in pea yields being very low less than 4.0 t/ha, therefore, there is a need to increase pea yields that allow increasing it, making it necessary to develop new varieties in pea cultivation, with high yield potential for the benefit of farmers. For this reason, the present research is proposed to evaluate the selected lines in generation F8 coming from segregating populations of the hybrid "Utrillo x INIA-102 Usui", obtained using the emasculation technique, said line, future improved cultivar, must have the characteristics of the male parent "INIA-102 Usui" such as its greater rusticity and tolerance to unfavorable conditions and adaptability to the Andean area and of the female parent "Utrillo" its good quality of large pod and intense green grain.

The project is justified in order to complete the release of new technology in Peru, since there are no genetically improved pea cultivars available so that producers can acquire these seeds.

II. Methodology

Table 1. Informative data: Location of the field where the experiment was set up.

Locality	UTM Location Altitude
Huaral–EEA Donoso	-11.5170404, -77.2385279 180 msnm

Source: Google heart *Figure 1.* Study areas

Source: *Google Earth - satellite*

The type of research that was developed using the randomized complete block design (DBCA) was used, having 10 treatments (08 lines selected from the cross between the parents "Utrillo" x "INIA-102 Usui" and two witnesses the father "INIA-102 Usui" and the mother "Utrillo") with 04 forests in the town of Huaral . Table 2 presents the Analysis of Variance equation:

Linear Additive Model (bad)
$\tilde{Y}ij = U + Ti + Bj + Ɛij$

Being:
i = 1, 2,… …., 06 Treatments j = 1, 2, 3,4 Blocks;
Where:
$\tilde{Y}ij$ = Observed value due to variation.
U = Overall mean of the experiment.
Ti = Effect of the i-th treatment.
Bj = Effect of the j-th block.
Ɛij = Effect of experimental error on observation

Table 2 *Analysis of Variance Table*

FV	GL	SC	CM	Fcal
Block	4-1 =3	SCb	SCb/3	CMb/CME
Treatments	10-1 = 9	SC_t	SCt/5	CMt_L/CME
Mistake	39-12= 27	SCe	SCe/17	
TOTAL	(4 x 10)-1 =39	SC_T	-	-

Source : Own elaboration

2.1. Treatments

Table 3. *Description of treatments*

Treatment	Identification 2021
1	Line 1
2	Line 2
3	Line 3
4	Line 4
5	Line 5
6	Line 6
7	Line 7
8	Line 8
9	Maternal parental witness - Usui
10	Paternal parental witness - Utrillo

Source: Own elaboration

Table 4. *Random distribution of treatments in the experimental field*

Blocks	Randomization of treatments (Lines T1 to T8 and 2 Parental T9 and T10)									
Yo	T1	T4	T8	T7	T3	T9	T2	T5	T10	T6
II	T5	T2	T9	T6	T1	T10	T3	T7	T8	T4
III	T3	T8	T4	T2	T1	T7	T6	T1	T5	T9
IV	T6	T1	T5	T8	T2	T3	T9	T4	T7	T10

Source: Own elaboration

2. 2. *Variables to be evaluated*

Independent variables (X)

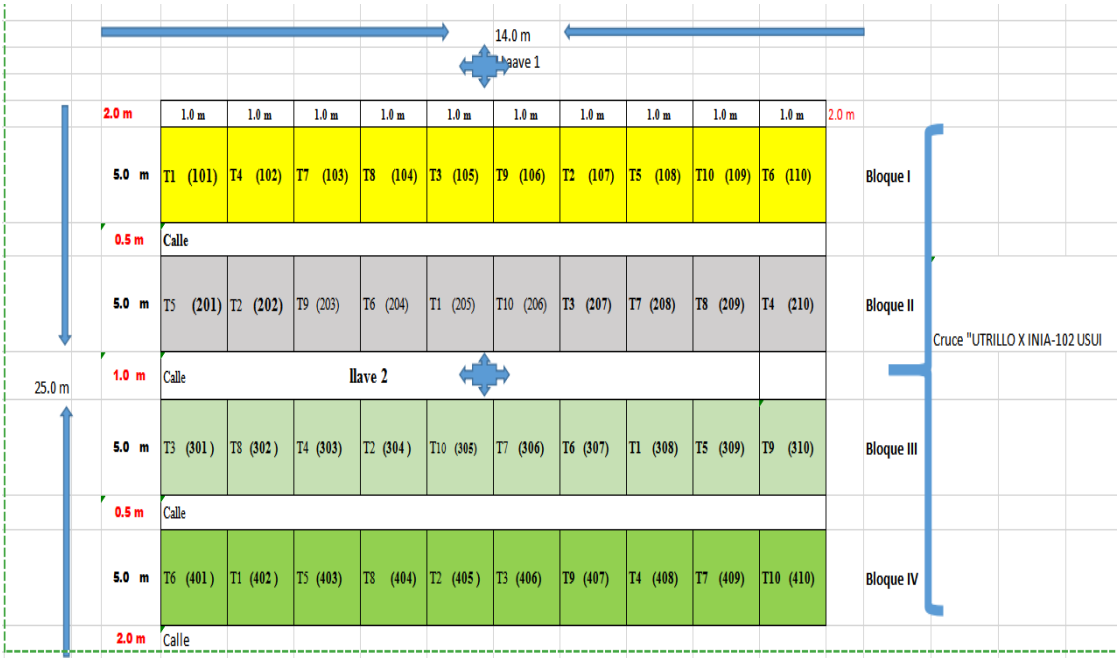
X1: Green pea lines from the cross "Utrillo x INIA-102 Usui" and compared with the controls the parents "Utrillo and "INIA-102 Usui".

Dependent variables (Y):

Y1: Plant germination (%)
Y2: No. of plants at harvest
Y3: Green pod weight. (g)
Y4: Sheath length and width (cm).
Y5: Commercial yield in green pod Kg/Plot
Y6: Commercial yield in green pod Kg/ha

2.3. Sketch of experimental field

Figure 2 . Treatment arrangements in the experiment



2.4. Operationalization of variables and indicators

Table 5. *Operationalization of variables and indicators*

Variables	Indicators
Plant germination (%)	%
N. of plants at harvest	
Green pod weight. (g)	Gr.
Sheath length and width (cm).	
Commercial yield in green pod Kg/Plot	Kg/ha
Commercial yield in green pod Kg/ha	
	cm.

Source: Own elaboration

Information processing

The student version of the Infostat program from the University of Córdoba (Argentina) was used. Analysis of Variance techniques were applied and subsequently, to make comparisons of X between treatments, the Duncan test was used with a margin of error of $\alpha = 0.05$.

III. Results

We present the results of the research in tables and graphs of the research, which have been obtained through the application of the data collection instruments Yield of pea lines (kg/ ha) in table 5, the following shows the analysis of variance for yield, where for the source of variation of blocks and treatments there were statistically significant differences, the coefficient of variation being 30.87 % and the general average being 7,409.8 kg / ha.

According to the Duncan comparison test at 5%, it was determined that line 7 and line 3 yielded more than 9,100.00 kg/ha and the lowest yield was obtained by Utrillo T 9, with 4,607.27 kg/ha.

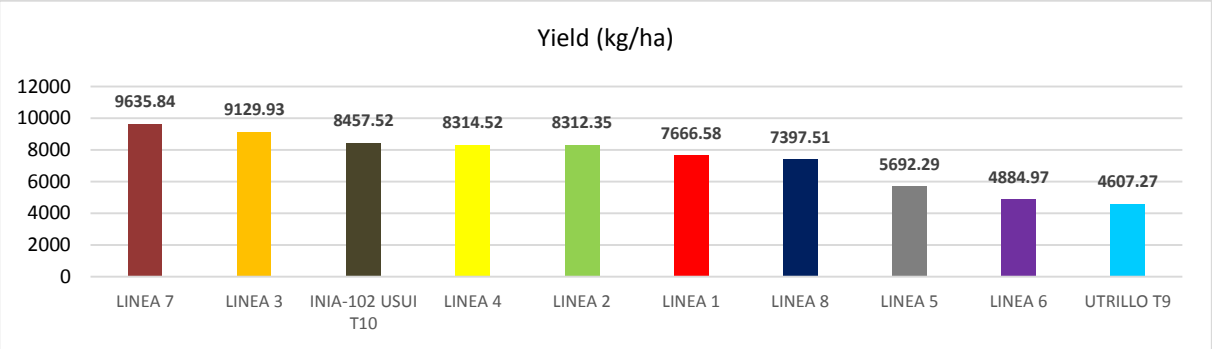
Table 6 *Duncan yield test (kg/ha)*

Treatment	Yield (kg/ha)	Significance at 5%
Line 7	9635.84	to
Line 3	9129.93	to
INIA-102 Usui T10	8457.52	ab
Line 4	8314.52	abc
Line 2	8312.35	abcd
Line 1	7666.58	abcd
Line 8	7397.51	abcd
Line 5	5692.29	bcd
Line 6	4884.97	CD
Utrillo T9	4607.27	d

Source: Field work

Interpretation of Table 6. The values with the highest values correspond to lines 7 and 3 and have the same level of significance (a). significance level (a). The other lines in treatment have lower yields, the lowest being Utrillo T9. The other lines in the treatment have lower yields, the lowest being Utrillo T9. The other lines in the treatment have lower yields, the lowest being Utrillo T9; the significances denoted with the same letters correspond to the same significance level (a) of significance

Figure 3. Yield in kilograms per hectare (kg/ha) of seven pea lines



Source: Own elaboration

According to the Duncan comparison test at 5%, it was determined that for pod width (cm), there was no significance between Line 1, Utrillo, Line 5, Line 8, Line 6, Line 2 and Line 7 , in which more than 1.6 cm was obtained, but it was observed that it did differ from LINE 4, INIA-102 Usui, and Line 3, in which less than 1.6 cm was obtained, as seen in Table 10 and Figure 3, these results are explained by why those with greater pod length have a wider pod character inherited from the parent "Utrillo".

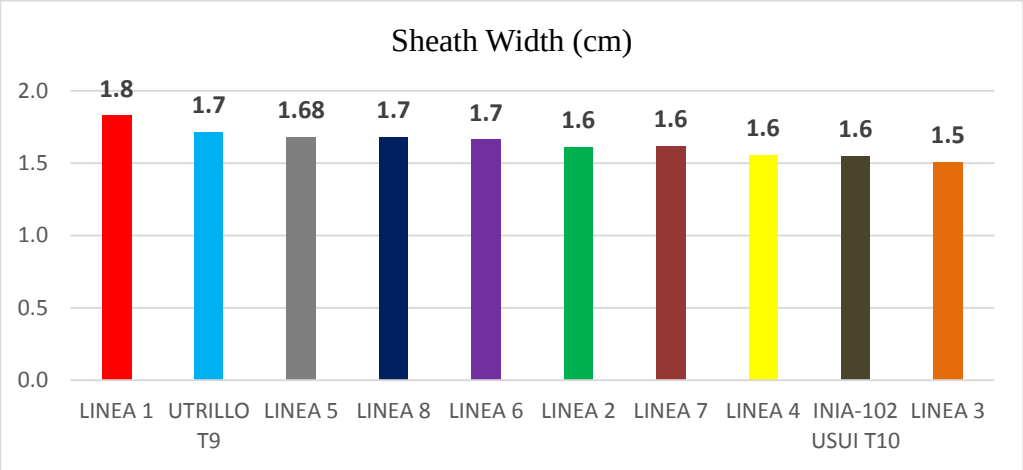
Table 7. Duncan test for pea pod width (cm)

Treatments	Sheath Width (cm)	Next at 5%
Line 1	1.8	to
Utrillo T9	1.7	ab
Line 5	1.68	ab

Line 8	1.7	ab
Line 6	1.7	ab
Line 2	1.6	ab
Line 7	1.6	ab
Line 4	1.6	b
INIA-102 Usui T10	1.6	b
Line 3	1.5	b

Interpretation of Table 7. The highest values of sheath width in centimeters correspond to the lines 1 with almost 2 cm. 1 with almost 2 cm; and have different levels of significance with all the other lines in Treatment because they are. The highest values of sheath width in centimeters correspond to line 1 with almost 2 cm, and have a different level of significance with all the other lines in Treatment because they appear with a different letter (a); line 3 has less sheath width of 1.5 centimeters and has the same level of significance (b) with all the other lines. level of significance (b) with the two penultimate lines of this Table.

Figure 4 *:* Pod width (cm) in 8 lines and 2 pea parents



Source: Own elaboration

4. Discussion

In the present work, line 7 and line 3 had the highest yields with 9,635.84 kg/ha and 9,129.93 kg/ha, which is similar to what was found by Barzola et al (2018) in their research work, whose yield of commercial varieties of fresh pea pod grain stood out the Utrillo, Quantum and Hybrid varieties with more than 8.28 t/ha.
Regarding the length and width of the pod, all the lines studied were similar with an average of 10.00 cm in length and 1.7 cm in pod width, which is similar to the largest pod found by Muñoz (2013) with Alexandra, which measured 10.3 cm.

4.1. Furthermore, this research is linked to the following investigations **:**

Checa, O., Rodríguez, D., Ruiz, M., & Muriel, J. (2021).
This paper addresses research and technology applied to pea cultivation in southern Colombia. Its approach is crucial for improving pea yield and quality, as it provides specific information on agricultural practices that affect production in different regions. Research on pod quality and yield in pea breeding lines in the Huaral Valley can benefit from the technologies and practices described in this study, especially in relation to improving the genetics of pea varieties.

Colque, J. (2019). This study examines the economic evaluation of onion production in the municipality of Achacachi, Bolivia. Although it focuses on a different crop, its methodological

approaches on economic evaluation are valuable for the evaluation of pea. The application of economic methods to agricultural production can help to understand the profitability of pea production in different regions, such as the Huaral Valley. In addition, this approach can serve to identify the costs associated with quality management practices that affect crop yield.

Corficolombiana. (2022). The report on the profitability of equity in Latin America offers information on the economic conditions that can influence the prices and costs of agricultural crops. The profitability of pea agricultural production can be closely linked to macroeconomic factors, such as interest rates and financial conditions. The study of these aspects is crucial for economic decision-making in pea production, since input costs and accessibility to financing can directly affect the yield and quality of the pod; which may be considered within the Administrative Management and Teaching Practice programs in a public Educational Institution as indicated by Rojas (2021)

National Administrative Department of Statistics (DANE). (2021). The diagnosis of the care economy is important in understanding how local economies, particularly rural ones, are influenced by the interaction of various factors. For pea cultivation, in particular, economic and social studies are crucial to assess how working and living conditions affect productivity in agricultural areas. DANE's findings could help improve the living conditions of pea producers in the Huaral Valley, which could lead to improvements in crop yield and quality.

National Federation of Cereal, Legume and Soybean Growers of Colombia (FENALCE). (2023). This FENALCE report provides historical data on area, production and yield of cereals and legumes in Colombia. Pea is a legume included in this analysis and its results can serve as a reference for yield studies in the Huaral Valley. Historical data helps to understand trends in pea production and yield, which is essential for efficient crop management and optimization of agricultural practices in the region.
Garay et al. (2022), in their study on the execution of public works and results-based management in a regional government in Peru, highlight the importance of strategic planning and the linking of the results obtained with the actions implemented. This approach can be useful in the agricultural field, especially in the production of crops such as peas, by applying a results-based model to optimize productivity. Results-based management in agriculture would allow for more effective evaluation of yields, ensuring continuous improvement and sustainability of agricultural practices.

Ramos Quispe (2022) presents a proposal for a questionnaire to evaluate work performance and human interrelations in universities. This type of evaluation can be adapted to agro-industrial sectors, such as pea cultivation, to measure worker productivity and well-being. The interrelation between employees and administrative management is essential to maintain an adequate work environment, resulting in greater harvest efficiency and crop quality. Implementing evaluation tools in agro-industrial labor management can foster the development of a more collaborative work environment.

Mendizábal et al. (2022) address the management of psychomotor skills and the right to life, reflecting on the lessons learned during the COVID-19 pandemic. In pea cultivation, the health of workers is essential to maintain stable and quality production. In addition, organizational resilience and adaptation to critical situations, such as those generated by the pandemic, are key to ensuring the sustainability of crops in adverse times.

Barreto & Barreto (2022) address the workload and living conditions of health personnel during the period 2022-1, highlighting how burnout and working conditions impact performance. This study is relevant to the agricultural sector, as agricultural workers, especially during intensive harvests, may face similar conditions. Overwork in pea harvesting, without adequate rest and working conditions, can lead to a decrease in performance. Therefore, it is crucial to manage the balance between workload and working conditions to avoid burnout and ensure greater productivity.

Espinoza Vásquez and Juárez-Gutierrez (2022) analyze the organizational climate and user satisfaction in a municipality. The organizational climate, which directly affects job satisfaction, is a key concept that can also be applied in the agricultural context. In pea farming, a positive organizational environment favors worker motivation and performance. Creating a healthy and collaborative work environment not only improves employee performance, but also has a direct impact on the quality and quantity of the harvested products.

Seminario Unzueta, Pérez García, Micha Aponte, and Ayvar Bazán (2022) propose a sociocritical model for managing physical activity in university students. Although the study is focused on the educational field, its principles can be applied to agroindustrial management. In the case of pea production, promoting physical activity and the well-being of workers not only improves their health, but also their ability to cope with the physical demands of the harvest. A sociocritical management model that values worker well-being is key to greater productivity and sustainability in the agricultural sector.

González, S., Guajardo, L., Almeraya-Quintero, X., Pérez-Hernández, L., & Sangerman-Jarquín, D. (2018). This article presents a typology of maize producers in Chiapas, Mexico, allowing for a comparison of agricultural practices across different regions and crops. Although it refers to maize, the typology of producers can be useful for identifying common patterns in pea producers. This includes aspects such as farm structure, use of technology, and access to resources, factors that directly affect crop yield and quality. The conclusions of this study can be applied to pea in regions such as the Huaral Valley.

V. Conclusions

According to the results obtained, it is concluded that the lines Line 7, Line 3, have a higher yield of more than 9,100.00 Kg/ha due to their good pod characteristics.
Regarding pod length (cm) and pod width (cm) all lines were similar.

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