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Productivity of fifteen traditional cultivars of Phureja potato in eight different environments

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Abstract

The productivity of fresh tubers and dry matter of 15 traditional potato cultivars of the Phureja group from Cajamarca was evaluated, in eight different environments. Sowings were carried out in the valley of Cajamarca. The randomized complete block design was used, with 15 treatments and three repetitions. The sowing was carried out at 0.9 m between furrows and 0.4 m between plants. 5 t ha^{-1} of worm humus and a compound fertilizer (15-24 -14 of N, P and K) at the rate of 300 kg ha^{-1} were applied. Eight plants per treatment were taken at harvest and the variables related to yield were evaluated. Significant statistical differences were found between cultivars for the variables: total weight of tubers, weight of commercial tubers, total number of tubers, number of commercial tubers, plant height, number of stems and dry matter. The cultivars 'Chachapoyana', 'Montañera', 'Blanca' and 'Shoga' were the best in fresh tuber yield and the cultivars 'Piña amarilla', 'Shoga' and 'Porpora' the best in dry matter. The environments presented significant statistical differences for the variables NTT, NTC, AP and NT.

Keywords: Andean, ecology, production.

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Introduction

The potato (*Solanum tuberosum* L.) of the Phureja group is important in Peru and other Andean countries for its attributes for genetic improvement, the market and fresh and processed consumption (Piñeros, 2009; Rozo and Ramírez, 2011). Due to its comparative advantages, this potato is the subject of studies from different approaches.

In recent years, studies have been especially aimed at knowing its advantages from the physical-chemical point of view (content of dry matter, protein, starch, total sugars and reducing sugars) (Cerón-Lasso *et al*., 2018). Other studies assess the content of secondary metabolites (carotenoids, phenols and anthocyanins), vitamin C and the antioxidant power of this set of compounds (Bonierbale *et al*., 2009; Díaz *et al*., 2014; Molina *et al*., 2015; Parra-Galindo *et al*., 2016). Macro and micronutrients have also been studied, especially Ca, Fe and Zn (Peña *et al*., 2015). Similarly, their advantages for the food industry were studied (Rivera *et al*., 2011; Cruz *et al*., 2016; Alarcón *et al*., 2016) and in particular, starches (Martínez *et al*., 2015).

Colombia is the country that has best taken advantage of this potato, both for the domestic and foreign markets. A few years ago, its exports in various derivatives amounted to more than 1 000 t year^{-1}. In Peru, its benefits have not been taken advantage of, on the contrary, this potato is disappearing in an accelerated way (Zimmerer, 1991; Haan, 2009; Seminario and Zarpán, 2011). However, the explorations of recent years indicate that, in northern Peru, particularly in Cajamarca, there are various cultivars that differ mainly by the shape, color and size of the tubers and the shape and color of the flowers. These are planted in small areas by traditional farmers, for self-consumption and market purposes (Seminario and Zarpán, 2011; Seminario *et al*., 2019).

Studies on the yield of fresh tubers of the Phureja potato vary widely. Thus, for example, with traditional cultivars -not improved-, reported yields are 11.8 to 23 t ha^{-1} (Bautista *et al*., 2012), 13.9 to 21.9 t ha^{-1} (Gómez-García, 2017) and 6.2 to 27.4 t ha^{-1} (Seminario *et al*., 2017). On the other hand, with cultivars improved through crosses and selection, higher yields are mentioned. Thus, 35 to 41.8 t ha^{-1} (León and Monteros, 2010) 31.7 to 34.3 t ha^{-1} (Santa María *et al*., 2010) and 32.9 to 37.4 t ha^{-1} (Rodríguez *et al*., 2014).

For this reason, it is important to study the productive potential of the cultivars of each region, to select those that stand out for this characteristic and to carry out studies on the best use in fresh and processed and their intervention in the generation of improved varieties. In this sense, the objective of this research was to evaluate the components of the yield and productivity of fifteen traditional cultivars of the Phureja group from Cajamarca, in eight different environments, in the same locality, but in different years and months of sowing.

Materials and methods

Fifteen native cultivars of the Phureja group (Table 1) from the work collection of the Andean Roots and Tubers Program of the National University of Cajamarca (PRTA-UNC) were used. These cultivars come from the Cajamarca region, they were morphologically characterized and are formally cataloged (Seminario *et al*., 2019).

Table 1. Potato cultivars of the Phureja group from Cajamarca, used in research.

Cultivar	Abbreviation	Origin	Tuber shape
‘Chachapoyana’	Cha	Bambamarca	Oblong
‘Montañera’	Mon	Bambamarca	Round
‘Blanca’	Bla	Bambamarca	Compressed
‘Shoga’	Sho	Jesús	Oblong
‘Piña amarilla’	Pam	Jesús	Compressed
‘Mulla’	Mul	Jesús	Elliptic
‘Poropora’	Por	Bambamarca	Oblong
‘Limeña’	Lim	Chota	Compressed
‘Amarila mahuay’	Amh	Jesús	Compressed
‘Limeña hachuma’	Lih	Jesús	Compressed
‘Huagalina’	Hua	Hualgayoc	Elliptic
‘Amarilla’	Ama	Jesús	Compressed
‘Yuquilla’	Yuq	Jesús	Elliptic
‘Huevo de ruco’	Hur	Bambamarca	Obovate
‘Huamantanga’	Hut	La Encañada	Ovate

The soil where the sowing was carried out corresponds to a lot of approximately 0.7 ha, located in the Cajamarca Valley, at 2 650 masl. In this lot, sowings were carried out in a crop rotation system that includes yacón, potato, rest, potato, yacón, rest. The soil is of clay loam texture and the averages of eight samples taken in different years and points indicated that the pH is neutral to slightly acidic, the content of organic matter (MO) is low and those of phosphorus (P) available and potassium (K) available were from medium to high (Table 2).

Table 2. Values of pH, MO, P available and K available of the soil where the sowings were carried out.

No.	pH	MO	P available	K available	Laboratory/Code
1	7.3	3.8	13.8	213.3	Tec. Des. Agr. JD. SRL.JD15-0122
2	6.9	4	11.8	239.5	Tec. Des. Agr. JD. SRL. JD1700
3	6.6	3.2	23.8	295	Est. Exp. BI, INIA. SU0287-EEBI
4	6.4	1.5	30.5	300	Est. Exp. BI, INIA. SU1253-EEBI
5	6.2	2.1	21.5	290	Est. Exp. BI, INIA. SU0787-EEBI
6	7.5	3	15.2	237	UNALM, 9431.
7	5.7	2.4	19	265	Est. Exp. BI, INIA. SU1252 – EEBI.
8	6.6	2.4	35.5	310	Est. Exp. BI, INIA. SU0794-EEBI.
Average	6.6	2.8	21.4	268.7	

Tec. Des. Agr= Technology and Agricultural Development. Est. Exp. BI, INIA= Baños del Inca Experimental Station, National Institute of Agrarian Innovation. UNALM= National Agrarian University La Molina.

For eight years, the 15 cultivars were planted on different dates (Table 3). The basic climatic variables and the season (rain/dry) under which the sowings were carried out are presented in Table 4. The most notable difference between seasons is the amount of rain, however, this lack of rain in the dry season sowings was overcome with the application of gravity irrigation. The difference in average temperature was 0.55 °C, in minimum temperature was 2.6 °C and in hours of sunlight of 1.7 h.

Table 3. Sowing and harvest dates and trial season.

No.	Sowing date	Harvest date	Season
1	20-12-10	18-04-11	Rain
2	30-04-11	03-09-11	Dry
3	28-11-11	10-04-12	Rain
4	25-05-12	07-10-12	Dry
5	01-09-12	09-01-13	Dry/rain
6	25-06-14	12-11-14	Dry
7	25-11-15	31-03-16	Rain
8	27-07-17	05-12-17	Dry/rain

In each year's sowing, each cultivar occupied a furrow with 10 plants. In this way, each sowing (in a different environment) constitutes a block or repetition. The experimental design of randomized complete blocks was used, with 15 treatments (cultivars). Sowing distances were 0.9 m between furrows x 0.4 m between plants (27 778 plants ha^{-1}). In each sowing, 5 t ha^{-1} of worm humus and 300 kg ha^{-1} of the Compomaster papa sierra compound fertilizer, which contains 15%, 24% and 14% of nitrogen, phosphorus and potassium, respectively, were applied.

At harvest, eight plants were evaluated, discarding the plants from the ends to avoid the edge effect. The cultural management of the crops consisted of weeding, irrigation and sanitary control, according to the specific needs of the crop and according to the season, following the recommendations for this type of potato established by the PRTA-UNC and Navas and Díaz (2012).

Table 4. Values of the basic climatic variables during the months and years in which the sowing was carried out.

Variable	Sowing 1: 2010				Sowing 2: 2011				Sowing 3: 2011				Sowing 4: 2012			
	Jan-2011	Feb-2011	Mar-2011	Apr-2011	May-2011	Jun-2011	Jul-2011	Aug-2011	Dec-2011	Jan-2012	Feb-2012	Mar-2012	Jun-2012	Jul-2012	Aug-2012	Sep-2012
Pp (mm)	76.6	73.3	125.2	102	16.7	0.4	8.3	0	110.6	154.2	155.3	127.8	0.9	0	2.6	19
T °C	14.6	14.2	13.9	14.4	14.4	14.2	13.9	14.4	14.9	14.2	14.4	15	13.6	13.8	14.2	14.6
Tmax (°C)	21	20.8	20.2	20.9	21.7	21.7	21.2	22.2	21	20.9	20.6	21.3	21.6	22.0	22.1	21.9
Tmin (°C)	9.1	8.5	8.5	9.4	6.6	6.1	5.9	6	9.8	7.6	9.3	9.9	5	4.8	5.5	6.6
HR (%)	71	77	72	70	62	61	62	60	67	64	68	71	63	58	57	62
Hours of sunlight	4.5	4.1	3.5	5.1	5.8	6.6	6.4	8.3	4.7	5	5.5	4.1	8	7.8	8.7	5.8

Variable	Sowing 5:2012				Sowing 6:2014				Sowing 7: 2015				Sowing 8:2017			
	Sep-2012	Oct-2012	Nov-2012	Dec-2012	Jun-2014	Aug-2014	Sep-2014	Oct-2014	Dec-2015	Jan-2016	Feb-2016	Mar-2016	Apr-2017	Sep-2017	Oct-2017	Nov-2017
Pp (mm)	19	83	120	58.9	1.9	3.8	28.5	26.6	39.5	27	85.3	12.3	20.9	21.5	65.3	63.2
T °C	14.6	15	15.4	15.3	14.4	14.3	9.7	15.4	16.5	16.5	16.4	16.2	14.5	15.3	15.7	15.7
Tmax (°C)	21.9	21.2	21.6	22.1	22.3	21.5	21.9	22.4	22.9	23.7	22.3	22.5	22	21.1	22.5	23.2
Tmin (°C)	6.6	9.5	10.2	9	5.8	5.9	7.6	8.7	10.4	10.5	11.8	10.6	6.5	8.3	8.8	8.4
HR (%)	62	67	66	62	57	55	60	57	67	69	70	69	60	54	54	58
Hours of sunllight	5.8	4.7	5.6	6.3	7.9	6.7	5.6	5.1	4.7	6.8	4	4	7.3	5.2	6.5	6.5

Every four columns correspond to the four months (abbreviated by the first letter) of each sowing. T °C= corresponds to average daily temperature. The number of each sowing corresponds to the sowing number in Table 3. In gray the sowings in dry season. Source: Augusto Weberbauer Meteorological Station (2 650 masl), agreement UNC-SENAMHI.

The variables evaluated were total tuber weight (PTT); weight of commercial tubers (PTC); total number of tubers (NTT); number of commercial tubers (NTC); plant height (AP); number of stems and the dry matter yield of tubers. This dry matter was determined based on the percentage of dry matter of the cultivars obtained during the characterization Seminario *et al.* (2019). The discrimination of commercial tubers was carried out with the classification of Pérez *et al.* (2008) and the criteria established by Seminario *et al.* (2018), in round and compressed tubers: diameter greater than ≥ 2 cm and in oblong, elliptic and obovate and ovate tubers: L + A/2 ≥ 2 cm.

The data of the variables under study were analyzed using the program SAS version 9.4. First the analysis of variance (Anova) was performed and then, depending on the significance of this test, Duncan’s multiple-range test was performed. In addition, correlations were made between the variables related to the yield and the total weight of tubers. Fresh tuber yield per hectare was calculated using Hay and Walker’s (1989) equation: fresh tuber weight (ha) = planting density x number of tubers per plant x average tuber weight. The dry matter yield per hectare was determined by multiplying the average weight of the plant’s dry matter by the number of plants per hectare.

Results and discussion

Yield of fresh tubers and related variables

Highly significant statistical differences ($p > 0.01$) were found for cultivars in the six variables studied (Table 5); that is, there are real differences between the averages of these variables. These differences are probably explained by the genetic variability of the cultivars under study.

Table 5. Mean squares and significance of Anova, for the total weight of tubers per plant (PTT) and related variables of 15 potato cultivars of the Phureja group from Cajamarca, in eight environments.

Source variation	Degrees of freedom	PTT (g)	PTC (g)	NTT	NTC	AP	NT	MS
Block	7	7 301.12 ns	2 363.82 ns	4.27 **	0.89 **	0.89 **	0.21**	408.0948*
Cultivars	14	46 043.15 **	27 633.35 **	3.23 **	0.37 **	0.37 **	0.24**	2 190.6406**
Error	98	3 581.32	2 520.83	1.13	0.18	0.18	0.07	185.1059
Total	119							
CV (%)		21.7	27.6	26.9	20	20	13.5	21.9

PTT= total weight of tubers (g); PTC= weight of commercial tubers (g); NTT= total number of tubers, NTC= number of commercial tubers; AP= plant height (cm); NT= number of stems; CV= coefficient of variation (%). *Significant. **Highly significant; NS= not significant; MS= dry matter.

Statistical significance ($p > 0.01$) was also found for the environments (repetitions) in four yield-related variables (NTT, NTC, AP and NT), which suggests that the environments where the trials were carried out (different years and months) influenced the evaluated components, in a differentiated way. The coefficients of variation varied between 13.5% and 27.6%, these values are considered acceptable for the field conditions where the trials were carried out (Vásquez, 2014). This influence was to be expected because sowings were carried out in different seasons (rain and dry) and where temperatures, rainfall and hours of sunlight varied significantly (Table 4).

In previous tests with cultivars of the same group, statistical differences were found for most of the variables evaluated here (Pérez *et al*., 2008; Rozo and Ñustez, 2011; Rojas and Seminario, 2014; Seminario *et al*., 2017; Seminario *et al*., 2018). These similarities are important because they allow identifying the quantitative variables that differentiate the cultivars and also to identify the basic components of the yield such as the number of tubers and the average weight of tubers per plant, which combined with the density of planting allow estimating the yield per hectare (Hay and Walker, 1989).

According to Duncan’s test (α= 0.05) (Table 6), it is observed that the cultivars ‘Chachapoyana’, ‘Montañera’, ‘Blanca’ and ‘Shoga’ are statistically similar and stand out for the total weight of tubers (PTT) and weight of commercial tubers (PTC) with respect to the remaining eleven cultivars.

Table 6. Duncan’s multiple-range test (α= 0.05) for the total weight of tubers and related variables of 15 potato cultivars of the Phureja group from Cajamarca, in eight environments.

Cultivar	PTT (g)	PTC (g)	NTT	NTC	AP (cm)	NT	MS (g)
Cha	406.7 a	277.3 a	16.4 ab	6.1 ab	56.6 d	5.1 a	81.3 ab
Mon	391.1 a	277.8 a	10.3 c	6.9 a	60.4 dc	5 b	74.3 abcd
Bla	382.8 a	267.9 a	16.4 abc	4.9 abcd	62.1dc	4.7 abcd	91.8 a
Sho	367.2 a	240.9 a	9.6 c	3.2 d	67.5 bc	4.2 bcde	88.1 ab
Pam	302.7 b	185.3 b	22.9 ab	5.6 abc	60.4 dc	3.6 cde	66.6 bcd

Cultivar	PTT (g)	PTC (g)	NTT	NTC	AP (cm)	NT	MS (g)
Mul	269.3 bc	174.2 bc	17 abc	4.3 bcd	70.6 ab	3.1 e	61.6 cdef
Por	267.5 bcd	178.8 bc	22.8 ab	4.3 abcd	57 d	3.7 de	64.2 cde
Lim	255 bcde	125.5 cde	11.7 bc	5.5 abc	59.7 dc	4.5 abcde	58.6 cdefg
Amh	228.5 cde	177.5 bc	11.5 bc	4.9 abcd	62.8 dc	3.8 bcde	61.7 cdef
Lih	227 cde	154.1 bcde	10.3 bc	4.8 abcd	65 bc	3.4 de	52.2 defg
Hua	223.2 cde	129.7 bcde	18.7 abc	4.9 abcd	62.1 dc	4.8 abc	42.4 efg
Ama	212.6 cde	171.3 bcd	20.1 abc	5.8 ab	76.3 a	5.4 a	57.4 defg
Yuq	200 de	146.2 bcde	22.3 ab	4.9 abcd	60.6 dc	4.6 abcd	39.8 fg
Hur	199 de	116.3 de	26.5 a	3.4 cd	48 e	4.5 abcde	51.7 defg
Hut	197.8 e	100.8 e	20.2 abc	4.7 abcd	66.2 bc	4.7 abcd	37.6 g

The cultivar ‘Chachapoyana’ ranks first in terms of the components total number of tubers (NTT), number of commercial tubers (NTC) and number of stems (NT). The cultivars ‘Huagalina’, ‘Amarilla’ and ‘Yuquilla’ do not show significant statistical differences for the variables NTT, NTC and NT. With regard to plant height (AP), the Cultivars Amarilla and Mulla do not differ statistically, but exceed the remaining thirteen cultivars.

The superiority shown by certain cultivars of the study group, with respect to the main components of the yield such as the number and total weight of tubers and, number and weight of commercial tubers constitutes an advantage that must be used to carry out specific yield tests, in order to identify the most productive cultivars in the region.

In previous studies with cultivars of the same group and from the Cajamarca region, other cultivars have stood out in the basic components of yield (NTT, NTC, PTT and PTC). Thus, they are mentioned as the best: ‘Roja-2’, ‘Piña amarilla’ and ‘Montañera-3’ (Rojas and Seminario, 2014). ‘Roja-2’, ‘Amarilla mahuay’, ‘Piña amarilla’, ‘Amarilla’, ‘Montañera-3’ and ‘Porpora’ (Seminario *et al*., 2017). ‘Blanca amarilla’, ‘Limeña huachuma’, ‘Llanqueja’, ‘Amarilla redonda’ and ‘Piña amarilla’ (Seminario *et al*., 2018). These elite cultivars are properly morphologically characterized (Seminario *et al*., 2019) and must be analyzed through specific studies.

Dry matter yield (g plant^{-1}) of cultivars

High statistical significance was found for the source of cultivar variation, meaning that there are real differences between the dry matter averages of the 15 cultivars. Similarly, there was statistical significance at 5% probability for blocks (Table 5), indicating that there was an environmental effect on the variability of dry matter content in g plant^{-1}. That is, the dry matter content is a genetically controlled character and is affected by the conditions of the environment and by the genotype x environment interaction (Vásquez, 1988; Hay and Walker, 1989). The coefficient of variation was 21.9%, an acceptable value for the field conditions where the experiment was conducted.

The Tukey multiple-range test (α= 0.05) (Table 6) indicated that there are no statistical differences between the cultivars 'Montañera', 'Chachapoyana-1', 'Shoga' and 'Blanca', whose averages vary between 74.28 g and 91.88 g, the cultivar 'Blanca' with the highest yield of dry matter (91.888 g plant^{-1}) stands out. A second group of cultivars was found, which consists of 'Piña amarilla', 'Poropora', 'Amarilla mahuay', 'Mulla' and 'Limeña', with averages varying between 66.613 g plant^{-1} and 58. 638 g plant^{-1} of dry matter, but no statistical difference between them.

The variation in dry matter yield among the 15 cultivars (37.58 g plant^{-1} to 91.88 g plant^{-1}) is explained because these are different genotypes and also by the environmental effect. It is known that the dry matter content is a polygenic character, highly heritable and of low interaction with the environment (Vásquez, 1988; Martínez and Ligarreto, 2005; Bautista *et al*., 2012). Several studies have shown that in these cultivars, it is expected that the highest proportion of dry matter is allocated to the tubers, which is demonstrated with the harvest index (IC). In general, IC values are higher than 40% (Rojas and Seminario, 2014; Saldaña *et al*., 2015; Seminario *et al*., 2019).

Thus, it is necessary to know which cultivars have the highest production of dry matter in tubers, which have an advantage for fresh consumption and processing. The higher dry matter content implies floury consistency, appreciated by the consumer, lower absorption of oil in frying and higher yield in starch, mash, powder, flakes and potato chips (Andrade, 1997; Ligarreto and Suarez, 2003).

Yield of fresh tubers (t ha^{-1}) and dry matter of tubers (t ha^{-1})

Fresh tuber yields per plant (g plant^{-1}) indicate 5 to 11 t ha^{-1} of fresh tubers (Figure 1). These yields can be considered low to moderate if compared with the maximum experimental yields in the region (27 t ha^{-1} to 28 t ha^{-1}). Nevertheless, they are close to the averages obtained in other studies with materials of the same group (Rojas and Seminario, 2014; Seminario *et al*., 2016; Seminario *et al*., 2017). It is important to note the high variability shown by tuber yield:

Thus, for example, in harvest II (dry season, 2011), the cultivar 'Chachapoyana' and 'Montañera' yielded 14.7 t ha^{-1} and 14.2 t ha^{-1} and the lowest yield corresponded to 'Limeña huachuma' with 5.3 t ha^{-1}. On the other hand, in harvest VI (2014), the lowest yield (3 t ha^{-1}) was recorded in the cultivar 'Porpora' and the highest yield (15 t ha^{-1}) corresponded to the cultivar 'Chachapoyana-1'.

Both harvests were produced in the rainy season, which shows that the yield is a multifactorial character, in which the factors of the environment have a differentiated impact on the genotypes. It can be inferred that the components number and total weight of tubers per plant and especially the number and weight of commercial tubers per plant played a decisive role in the definition of the total yield. Overall, for all cultivars, only 33% of tubers were commercial but this proportion ranged from 12.8% to 66.9% and their average weight was 37.5 g, but ranged from 21.4 g to 75.3 g. Likewise, it can be inferred that the differences between the values of the meteorological variables of the rainy and dry seasons played a compensatory role between them. For example, the lower average and minimum temperatures of the dry season were offset, in a way, by the higher hours of sunshine of this season and the lower hours of sunshine in the rainy season were offset by the higher temperatures. It is evident that, in field crops, it is almost impossible to find optimal conditions (environmental and management) for plants, as recommended by Navas and Díaz (2012).

The low yields are also explained by the plants only receiving a low dose of humus (5 t ha^{-1}) and a deep fertilization, also in low doses (15-24-14 of N-P-K). On the other hand, the backgrounds of experimental studies indicates that the Phureja potato has moderate to low yields, even when high levels of chemical fertilizer or organic fertilizer are applied (Pérez *et al*., 2008; Muñoz and Lucero, 2008; Gómez-García, 2017). However, these yields are offset by their precocity and high price in the market.

The dry matter yields in the tubers (g $plant^{-1}$) recorded in the 15 cultivars are equivalent to yields of 1 to 2.6 t ha^{-1} (Figure 1). These values are an expression of the genotype, due to the different percentage of dry matter in the tubers in each cultivar, which was determined during the previous characterization (Seminario *et al*., 2019) and except in one case (cultivar 'Shoga'), the best cultivars in fresh weight were not the best in dry matter (Figure 1). This information is important because it allows comparing and selecting cultivars for their efficiency in the use of external inputs and light energy and their transformation into organic matter, as an expression of net photosynthesis.

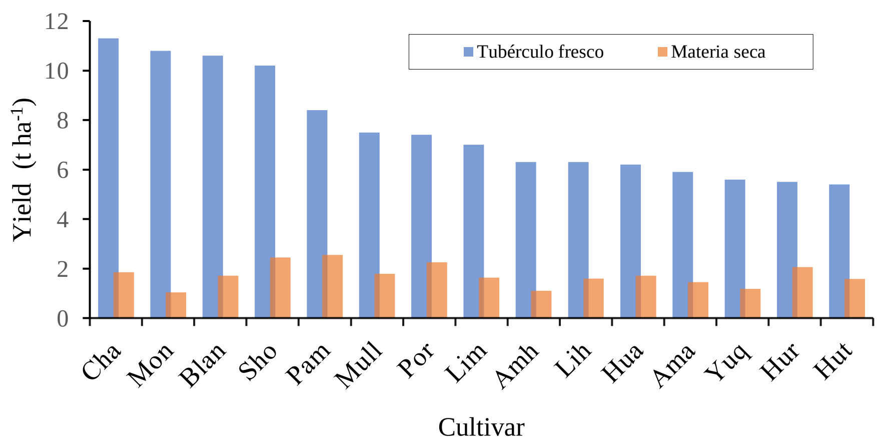

Figure 1. Yield of fresh tubers (t ha^{-1}) and dry matter (t ha^{-1}) of 15 potato cultivars of the Phureja group from Cajamarca, in eight environments.

Correlations and regressions between yield-related variables

A positive, highly significant correlation was found between PTC and PTT (r= 0.9387) The regression equation was: Y= 55.33 + 1.2x. The correlations between NTT, NTC, NT and AP, with PTT were low and not significant. The high positive correlation between PTC and PTT and the lack of correlation between NT and PTT is explained by the fact that crop produced abundant small tubers, smaller than 2 cm in diameter or smaller than 5 g (non-commercial) and commercial tubers, according to the classification of Pérez *et al*. (2008) (commercial ≥ 2 cm in diameter or greater than 5 g), were few (30% ± 10% of the total) and were the ones that most influenced the total weight of tubers per plant (Table 5). Likewise, the lack of correlation between NTT, NT and AP with PTT indicates that their relationships are not allometric or stable (Gardner *et al*., 1985) and on the contrary, these vary according to environmental and management conditions. Rojas and Seminario (2014) analyzing 10 cultivars from the same group also found a positive correlation (r= 0.074) between PTC and PTT.

Conclusions

Significant statistical differences were found between the 15 traditional cultivars of Phureja potato under study, for the variables PPT, PTC, NTT, NTC, AP, NT and MS. The cultivars 'Chachapoyana', 'Montañera', 'Blanca' and 'Shoga' were the best in yield of fresh tubers. On the other hand, in dry matter, the cultivars 'Piña Amarilla', 'Shoga' and 'Porpora' stood out (these groups of cultivars must be studied in specific tests). The weight component of commercial tubers was decisive in defining the total yield of fresh tubers (explained by its high degree of correlation, r= 0.93).

The environments (different years and months of sowing) presented significant statistical differences for the variables NTT, NTC, AP and NT. However, in general, their effects were compensatory, among their various factors (average temperature, maximum and minimum temperature, rainfall, relative humidity and hours of sunlight) and seasons, so that the best environment could not be determined.

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