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‘Croscat’ Common Bean (*Phaseolus vulgaris* L.), a Prototypical Cultivar within the ‘Tavella Brisa’ Type

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The cultivar Croscat is a common bean inbred line developed by the Fundació Miquel Agustí from the ‘Tavella Brisa’ landrace. This landrace is adapted to the climate (Mediterranean with Atlantic components) and soil (volcanic soil with high levels of potassium, very good water retention, and high cationic exchange capacity) of the Volcanic Region of Santa Pau in Garrotxa County in northeast Spain. Seeds are sown at the end of May or beginning of June, depending on the rains because the beans are cultivated without irrigation. Depending on the weather in the fall and the time when the seeds are sown, beans are harvested between the beginning of September and the end of October.

In the last 30 years, the ‘Tavella Brisa’ germplasm has suffered numerous introgressions (Sánchez et al., 2007) that have modified the populations and affected its sensory value. On the other hand, this landrace, which now includes growth Types I and II (Singh, 1982), was formerly grown together with maize and suffers from lodging, thus making mechanized harvesting difficult when it is cultivated without support. ‘Tavella Brisa Croscat’ was developed through selection with the aim of preserving the sensory traits of the landrace (low seed-coat perceptibility, medium–low mealiness, mild and pleasant taste, purple pod) and its tolerance to drought and heat stress while improving the architecture of the plant (more upright) to facilitate mechanized harvesting. The new cultivar is also a good starting point for introducing resistances to diseases and pests. Furthermore, the development of a homogeneous inbred line that has the main differential traits of the landrace helps support the application for the European label Protected Denomination of Origin (European Commission, 2006a; 2006b) that the area’s farmers have submitted.

Origin

Seventeen entries of ‘Tavella Brisa’ were collected from the production area and their agricultural and morphological traits were studied together with molecular markers. The results showed wide genetic variability between and within entries (Sánchez et al., 2007) in growth habit, intensity of pod color, maturity, leave size, drought tolerance, and yield, whereas sensory traits showed less genetic variation but more environmental variation. As a result of the high variability within entries, we built up a single selection pool representing the landrace mixing ≈20,000 seeds of all the entries we had collected. Field studies of this pool allowed us to identify diverse presumably inbred lines (no phenotypical segregation was observed between their progenies) that were interesting for some of the traits that we wanted to preserve or improve, but no single inbred line had all the desired qualities (upright architecture of the plants, short or medium cycle, high yield, round and not very big seeds, purple pods, low seed-coat perceptibility, and low mealiness). The inbred line L543, which has moderate yields and Type Ia growth habit (Singh, 1982), a short cycle, large leaves, large seeds, light purplish pod color, and high tolerance to drought (qualitatively measured through the plants’ appearance in dry periods and through production in dry years), was manually crossed in a greenhouse with the inbred line L214, which has high yield, Type Ib growth habit (Singh, 1982), a medium cycle, medium-sized leaves and seeds, strong purple pod color, and medium tolerance to drought. From this cross, we undertook a seven-generation pedigree-type breeding program starting with 73 F_2 families. Fifty plants from each family were controlled. We selected 72 of the 3600 F_2 plants to study their progenies obtained by selfing. This scheme was maintained through F_6. In F_3 and F_4, the selection was based mainly on the phenotype of individual plants, whereas in F_5, F_6, and F_7, the mean phenotypical value of the families was the determining trait of selection. At F_7, ‘Tavella Brisa Croscat’ was chosen from among nine candidate inbred lines as the closest to the ideotype we were seeking.

Description

We cultivated ‘Tavella Brisa Croscat’ in the locations Santa Pau, Santa Llúcia, and La Cot in the Volcanic Region of Santa Pau in 2006 and 2007. A sample of the selection pool (landrace) was used to control the advances in all desired traits. The Navy market class control T9905 (Hyland Seeds, div. of Thompsons Ltd., Blenheim, Canada) was also included in the experiment. We recorded parameters related to agronomic traits, plant morphology, and seed morphology according to IBPGR (1982) descriptors (Table 1) and sensory traits (Table 2).

The variety ‘Tavella Brisa Croscat’ belongs to the Navy commercial class (Voysest, 1999); it has an upright Type Ia growth habit (Singh, 1982) and white flowers on inflorescences protected under large leaves. The pods are green but change to purple while ripening (in Catalan language, the variety’s name means pod with the color of crushed grape skin) (Figure 1). This coloration is short-lived and the mature pod is parchment white. The seeds are small (25 g/100 seeds; Table 1), round, and white (Figure 1). The average yield is 1500 kg·ha^{-1}, which is similar to that of the landrace and of the commercial control (Table 1), but the variability in yields between years and between locations in the same year was much lower in ‘Croscat’ and in the landrace than in the commercial control (CVs 11%, 8%, and 63%, respectively). The control was especially sensitive to heat stress and drought.

The morphological aspects in which ‘Croscat’ is most different from the average of the landrace and more similar to the commercial control include fewer vines and more upright plants (Table 1). On the other hand, ‘Croscat’ has the characteristic purple pod of the landrace and some slightly larger leaves that protect the flower in the hottest periods (Table 1). Although a few ‘Croscat’ plants showed the classic symptoms of natural virus infection, no tests were performed to verify the presence of the virus. ‘Croscat’s’ upright architecture facilitates mechanized harvesting and prevents the losses that occur in the landrace resulting from lodging. The yields presented here correspond to manual harvesting in microplots (each plot consisted of five 5-m-long rows separated from one another by 0.75 m; only the three central rows were harvested) to ensure the entire crop was harvested. Dry seed yield of ‘Croscat’ and T9905 surveyed in mechanically harvested field trials was 25% higher than that of the original landrace (landrace control) as a result of the reduced losses during harvesting. Finally, ‘Croscat’ has a slightly shorter growth cycle than both controls. This is an advantage because there is a risk of frost at harvesting time.

No differences were observed between ‘Croscat’ and the initial landrace in seed-coat

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Table 1. Agronomic traits of 'Croscat', the landrace, and T9905.

Cultivar	Yield[y]	Wt g/100 seeds	Days to flowering	Days to maturity	Growth habit[x]	Plant architecture[w]	Leaf length cm	Leaf width cm	Plant ht cm	Virus[v]	Pod color[u]
Croscat	1527 a[z]	25.0 a	43.1 a	97.3 a	Ia	2.50 a	12.2 a	8.5 a	44.5 a	1.66 a	1.94 a
Landrace[t]	1321 b	24.7 a	46.9 b	104.7 b	I, II	1.58 b	10.9 b	7.4 b	45.2 a	2.12 b	2.19 a
T9905	1667 a	25.5 a	47.2 b	109.1 c	II	2.79 a	10.6 b	7.1 b	53.0 b	0.75 c	0.00 b

[z]Values for the same trait followed by the same letter were not significant at $P \leq 0.05$ in Duncan's multiple range test.
[y]Expressed in kg·ha^{-1}.
[x]According to Singh (1982).
[w]Evaluation of the plant's architecture according to the phenotype that facilitates mechanized harvesting on a scale from 0 (prostrate) to 3 (completely upright).
[v]Evaluation of bean common mosaic virus symptoms on a scale from 0 (no plants with symptoms) to 3 (many plants with symptoms).
[u]Intensity of the purple color of the pod on a scale from 0 to 3.
[t]Represented by a sample of the initial selection pool.

Table 2. Sensory traits of 'Croscat', the landrace, and T9905 quantified on a 10-cm semistructured scale with the extremes and the center of the line labeled with corresponding descriptions and culinary traits.

	Sensory traits			Culinary traits	
Cultivar	Seed-coat perceptibility[y]	Mealiness[x]	Flavor[w]	Cooking time (min)	Percent unbroken seeds after cooking
Croscat	4.84 a[z]	3.93 a	3.00 a	79 a	10 a
Landrace[v]	4.72 a	4.48 ab	3.71 ab	99 b	12 a
T9905	4.02 a	5.24 b	4.05 b	93 b	30 b

[z]Values for the same trait followed by the same letter were not significant at $P \leq 0.05$ in Duncan's multiple range test.
[y]0 stood for extremely low perceptibility, like the Ganxet Montcau bean boiled with distilled water, and 10 stood for very high perceptibility, like the Ganxet Montcau bean boiled in water containing 200 ppm of Ca (Romero del Castillo et al., 2008).
[x]0 meant high creaminess like the Ganxet Montcau bean boiled in distilled water and 10 meant high mealiness like the Tolosa bean cooked in distilled water (Romero del Castillo et al., 2008).
[w]0 meant mild bean flavor like Plancheta and 10 meant strong bean flavor like Tolosa (Romero del Castillo et al., 2008).
[v]Represented by a sample of the initial selection pool.

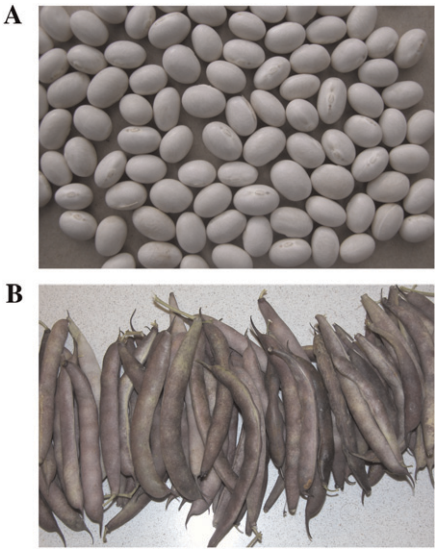

Fig. 1. Croscat seeds (**A**) and immature pods (**B**). Note the color of the immature pods that gives name to the landrace Tavella Brisa, origin of the new cultivar.

perceptibility, mealiness, or flavor (Table 2). Compared with 'Croscat', the commercial control T9905 was mealier and had a more intense flavor (Table 2). 'Croscat' cooks faster than the landrace and the commercial control and has the same low percentage of unbroken seeds after cooking as the landrace (Table 2).

In summary, the cultivar Croscat maintains the morphological and sensory traits that are typical of the landrace as well as its adaptations to the relatively hot and dry climate of Garrotxa County, protecting flowers with dense, large leaves; however, unlike the original landrace, 'Croscat's' upright architecture facilitates mechanized harvesting. Furthermore, because it is an inbred line, 'Croscat' can ensure the homogeneity of the product that reaches the market.

Availability

'Croscat' is an inbred line and a plant patent under the name of 'Croscat' is currently pending. Small samples of seed for research purposes are available through the Fundació Privada Miquel Agustí (info@fundacimiquelagusti.com).

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