Crop Breeding and Applied Biotechnology 12: 297-300, 2012
Brazilian Society of Plant Breeding. Printed in Brazil

CULTIVAR RELEASE

`IAC IMPERADOR´: early maturity "carioca" bean cultivar

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Received 15 June 2012

Accepted 27 September 2012

Abstract – *In the state of São Paulo, common bean is an important crop and the Agronomic Institute (Instituto Agronômico – IAC) registered the "carioca" (beige with brown stripes) bean cultivar IAC Imperador in the MAPA/RNC, exhibiting mean yield of 2,266 kg/ha in the 17 environments evaluated, a 75-day cycle, resistance to soil diseases and high quality seeds.*

Key words: Phaseolus vulgaris *L., common bean, yield, genetic breeding.*

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is one of the most important constituents of the Brazilian diet as it is an excellent source of protein. Brazil has the distinction of being the largest worldwide producer of common bean, with a total production of 3.77 million tons on 3.91 million hectares for the 2010/2011 crop season (CONAB 2011). In addition to its importance in the Brazilian diet, it is one of the agricultural products of greatest economic and social importance since it is grown on extensive areas and because of the labor it employs during the crop cycle. Considering these aspects, the common bean genetic breeding program of the IAC, undertaken in the Grain and Fiber Agribusiness Technological Research and Analysis Center of the Agronomic Institute, has made carioca common bean cultivars available with high yield capacity, resistance to the anthracnose pathogen (*Colletotrichum lindemuthianum*) and excellent cooking qualities (Carbonell et al. 2008, Carbonell et al. 2010, Chiorato et al. 2010). Another important characteristic is the early maturity of carioca common bean cultivars for composing new production systems with seed quality and disease resistance, currently not available on the market. The purpose of the present study was to present data from the common bean inbred line Gen P5-4-3-1 undertaken in VCU trials of the state of São Paulo which included the sowing period of the rainy season 2009, dry season 2010, winter 2010, rainy season 2010, dry season 2011 and winter 2011, resulting in the registry of the IAC Imperador common bean cultivar.

GENETIC ORIGIN AND DEVELOPMENT

The cultivar IAC Imperador, inbred line Gen P5-4-3-1, arose from the cross [(IAC Carioca Eté x Carioca Precoce) x IAC Carioca Eté] x 60 Dias, undertaken in the Agronomic Institute in Campinas, SP, from the years 1999 to 2005. In 1999, from the cross between the cultivars IAC Carioca Eté x Carioca Precoce and, F_1 seeds were obtained which were backcrossed with the cultivar IAC Carioca Eté. From this backcrossing and advancement of generations, the inbred line Gen99TG46-39-1 was obtained, which presented early maturity of around 75 days to harvest, but low yield potential, not being recommended for agribusiness interests.

In 2005 with a view toward development of early maturity cultivars, the cross between the traditional cultivar 60 Dias and the Gen99TG46-39-1 inbred line was made. From this cross, 11 F_1 seeds were obtained, which were then sown in pots in a greenhouse to obtain F_2 generation seeds. In 2006, with the F_2 generation seeds in hand, bulk selection was performed by means of a size 13 (13/64 x 3/4 inches) oblong

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sieve. Forty seeds were selected, which were then sown in a tray with sterilized vermiculite and inoculated with a mixture of the physiological strains 31, 65 and 89 of the anthracnose pathogen (*Colletotrichum lindemuthianum*). With this inoculation, eight resistant seedlings and 28 susceptible seedlings were obtained, with four seeds not germinating. The resistant seedlings were transplanted in pots in a greenhouse, obtaining 215 $F_{2:3}$ generation seeds, designating the initials P5-4 for this family, where the codes stand for:

P: Cross performed for early maturity;

5: Number of the inbred line Gen99TG46-39-1 used in the cross between the lines chosen as principal parents; and,

4: Number of the traditional cultivar 60 Dias used in the cross between the lines chosen as secondary parents.

In 2007, the 215 seeds proceeding from the $F_{2:3}$ family were sown in the Regional Center of the São Paulo Agribusiness Technology Agency - APTA located in the municipality of Monte Alegre do Sul – SP. Upon sowing, using the genealogical selection method, four plants were selected individually and the seeds were forwarded to the Agronomic Institute, IAC, in Campinas, SP. Seeds of the four $F_{2:4}$ families were sown in a field in the Agronomic Institute artificially infected with *Fusarium oxysporum*, being denominated with the respective initials: P5-4-1, P5-4-2, P5-4-3 and P5-4-4. With the evaluation, only the P5-4-3 family was notable in Campinas, obtaining seeds of the $F_{2:5}$ family at harvest. This family was once more sown in an area infected with *Fusarium oxysporum* in Campinas, in this cycle undertaking selection of a promising plant by the genealogical method. Upon the harvest of this plant, seeds of the $F_{2:6}$ generation were obtained and the breeding program established the initials Gen P5-4-3-1, considering the inbred line as promising for evaluation in other regions of the state of São Paulo.

After a cycle of multiplying seeds of the inbred line Gen P5-4-3-1 in the year 2008 in the winter sowing season, experiments were carried out in the São Paulo Agribusiness Technology Agency Centers – APTA, located in the municipalities of Votuporanga, SP and Colina, SP, respectively. In the municipality of Votuporanga, the inbred line Gen P5-4-3-1 exhibited a mean yield of 2,472 kg ha^{-1} and in the municipality of Colina, the mean yield of the inbred line was 3,767.75 kg ha^{-1}.

In 2009, at the time of the winter sowing season, two new experiments were undertaken in the APTA Centers located in the municipalities of Votuporanga, SP and Tatuí, SP. In the municipality of Tatuí, the mean yield of the inbred line Gen P5-4-3-1 was 2553 kg ha^{-1}, and in the municipality of Votuporanga, the mean yield was 2602 kg ha^{-1}. Thus, through presenting yield indexes above 2500 kg ha^{-1} and through being an early maturity genotype, allowing harvest at 75 days after sowing, the inbred line Gen P5-4-3-1 was designated to compose the VCU trails that included the sowing period of the rainy season 2009, dry season 2010, winter season 2010, rainy season 2010, dry season 2011 and winter season 2011.

SEED YIELD CAPACITY

In the VCU trails undertaken in the state of São Paulo, the yield potential of the cultivar IAC Imperador was 3,313 kg ha^{-1}, observed in the sowing period of the dry season in the municipality of Mococa, SP of a total of 17 VCU trials undertaken from the years 2009, 2010 and 2011, in which there were 25 genotypes from different research institutions in Brazil. Mean yield of ´IAC Imperador´ in these trials was 2,132 kg ha^{-1}, 2,146 kg ha^{-1} and 2,521 kg ha^{-1} for the periods of the rainy season (4 trials), the dry season (5 trials) and winter season (8 trials), respectively (Table 1).

Table 1. Yield (kg ha^{-1}), experimental coefficient of variation (CV%) and minimum significant difference (Dunett-5%) in relation to the best standard cultivar corresponding to seed color (Diverse = Carioca) per separate sowing time and jointly in VCU common bean trials for the state of São Paulo in 2009/2010/2011

Common bean cultivars	**Sowing period**			**Mean 2009/2010/2011** (kg ha^{-1})
	Rainy (4 environments)	Dry (5 environments)	Winter (8 environments)	
	kg ha^{-1}			
IAC Imperador	2,132	2,146	2,521	2,266
IAC Alvorada	1,929	2,172	2,471	2,191
Pérola	2,149	2,374	2,638	2,387
Mean[1] (kg ha^{-1})	2,110	2,269	2,476	2,329
CV (%)	21.30	18.60	16.70	18.40
MSD (kg ha^{-1})	548	467	355	251

[1] Experimental mean containing 25 cultivars and inbred lines with coefficient of variation less than 25%,
*Dunnett Test (5%) in relation to the best standard cultivar corresponding to the Diverse (Carioca) group.

Table 2. Technological and nutritional quality: mean values of cooking time in minutes by the Mattson Cooker and protein content (%) in common bean seeds of the VCU trail in 17 environments in the state of São Paulo in 2009/2010/2011

Season	IAC Imperador		Pérola		IAC Alvorada	
	Cooking time (min)	Protein content (%)	Cooking time (min)	Protein content (%)	Cooking time (min)	Protein content (%)
Rainy	25.49	18.47	28.11	19.52	27.37	22.50
Dry	24.58	24.11	28.16	20.50	30.36	23.00
Winter	35.02	20.59	40.08	19.78	37.14	22.16
Mean	27.36	21.06	31.00	19.93	32.47	22.55

The mean yield of 'IAC Imperador' did not differ from the best standard cultivar ('IAC Alvorada' or 'Pérola') at different sowing periods and in joint analysis of the periods. Thus, the cultivar IAC Imperador exhibited behavior similar to these standard cultivars, which present high seed technology and yield, but with a late cycle, allowing harvests only at 95 days after sowing.

OTHER CHARACTERISTICS

'IAC Imperador' has a semi-upright plant architecture with a shrubby growth form (type I), with resistance to anthracnose (*Colletotrichum lindemuthianum*), 1000-seed weight of 270 grams, carioca type seeds with light brown stripes. It has early maturity cycle of around 70 to 75 days from emergence to physiological maturity (presence of yellow pods/hulls) according to the environmental conditions in which it is grown. In inoculations in the laboratory and in seed producing fields, it showed resistance to fusarium wilt (*Fusarium oxysporum*).

The mean cooking time (minutes) of the IAC Imperador cultivar is less (27.36 min) than that of 'Pérola' (31.00 min) and of 'IAC Alvorada' (32.47 min), resulting in whole light-colored beans at the end of cooking. The protein content varied with the environment and on average 'IAC Imperador' has 21.06% in the beans (Table 2).

TECHNICAL RECOMMENDATION AND SEED PRODUCTION

Sowing should be undertaken in accordance with ecological zoning of the state of São Paulo, Paraná and Santa Catarina, for the regions recommended through agricultural zoning in effect for the crop. Between-row spacing of 50 cm with 12 final plants per linear meter is recommended, totaling 240,000 plants per hectare. Seed production began in the dry crop season of 2012 and registration in the RNC (National Cultivar Registry) and protection in the SNPC (National Cultivar Protection System) requested from MAPA in April, 2012.

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