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Chickpea breeding in Portugal

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SUMMARY - The Chickpea production has been popular since ancient times particularly in the rich and clay soils aof southern parts of Portugal. Problems of diseases and low productivity and high labour requirement have resulted in decreased interest in the cultivation of this crop. Studies on selection of improved varieties and production technology are being carried out by three research institutions of INIA, i.e. National Plant breeding Station, at Elvas; National Station for Agricultural Research at Oeiras; and National Station for Animal Research at Fonte Boa. Results obtained in the breeding area indicate good prospects for the introduction of some lines of chickpea from ICARDA and ICRISAT as autumn-planted crop, because of high yields and good economic returns. Studies on the chemical composition of the chickpea lines selected at Elvas show that they have good nutritional value.

RESUME - "Amélioration du pois chiche au Portugal". La culture du pois chiche est très ancienne et populaire surtout dans les régions de sols argileux du Sud. Problèmes de maladies, faible productivité et besoins en main, d'oeuvre élevés ont fait baisser nettement l'intérêt de cette culture. Un programme de sélection de variétés et d'amélioration des techniques de production est en cours, comprenant trois projets, mis en oeuvre par la Station Nationale d'Amélioration des Plantes, à Elvas, par la Station Nationale Agronomique à Oeiras et par la Station Nationale Zootechnique, à Fonte Boa (Institutions de recherche de l'INRA). Les résultats obtenus en matière d'amélioration génétique indiquent d'intéressantes perspectives pour l'introduction de certaines lignées de pois chiche ICARDA-ICRISAT en culture d'automne, compte tenu des forts rendements et des bonnes marges brutes. Les études sur la composition chimique des lignées sélectionnées à Elvas montrent qu'elles ont une bonne valeur nutritionnelle.

Introduction

Portugal has been facing an acute vegetable protein deficit. As the vegetable proteins are very important both in human and animal nutrition, the country has been making large imports, which is causing great drain on the foreign exchange. Amongst the common grain legumes (pulses) predominantly used as food, faba bean and chickpea are particularly important. However, since the early sixties a significant decline in cultivated area and total production has occurred for both crops. The decline has been much more pronounced for chickpea (Dordio, 1987).

Chickpea has been grown in Portugal since ancient times like in other Mediterranean countries and plays an important role in meeting the quantitative and qualitative protein and energy requirements of a large part of Portuguese population, mainly in the rural areas. Due to the decline in total production the chickpea imports increased continuously in spite of a light and persistent reduction in per capita consumption. For example, the per capita consumption reduced from 4.9 g per day in 1983 to 3.0 g (Dordio, 1987). One can explain this trend on the basis of a considerable reduction in the rural population and increased urbanization.

Recently many efforts have been made to reduce the heavy vegetable protein imports and farmers are attempting to diversify their cropping from the purely cereal monocropping. Consequently, good prospects for increasing the production of food legumes exist, and chickpea appears to be a particularly important crop in this regard in the near future. As Tavares de Sousa and Barradas (in press) have pointed out, it is however necessary to overcome some critical weak points of this species and its production constraints.

Production situation and constraints

For centuries chickpea has been cultivated in this country on the fallow lands before wheat according to the traditional agricultural system of the extensive dry farm-

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ing specifically used in the rich and clay soils of the southern part of Portugal. By traditional cropping chickpea is, as a rule, sown after the frosty period is over i.e. in February- March, which exposes the crop to the dry and hot period later in the season. This results in low yield.

Not only the area sown to chickpea but also its production show considerable fluctuations depending on soils moisture at sowing time and throughout the life cycle. The grain yield obtained under nonfavourable environmental conditions are frequently low and unstable.

It is also important to take into consideration the extremely high human labour input needed at harvest because the land races being grown are not suitable for mechanized harvesting. Low yields and high production costs are major factors forcing farmers to give up chickpea cultivation. The lack of marketing support and guarranteed prices are another disincentive to the farmers. As a result of these factors the total area and production of chickpea in Portugal are declining, and the grain yield, has continued to remain low (500 kg/ha) and shown in Fig. 1.

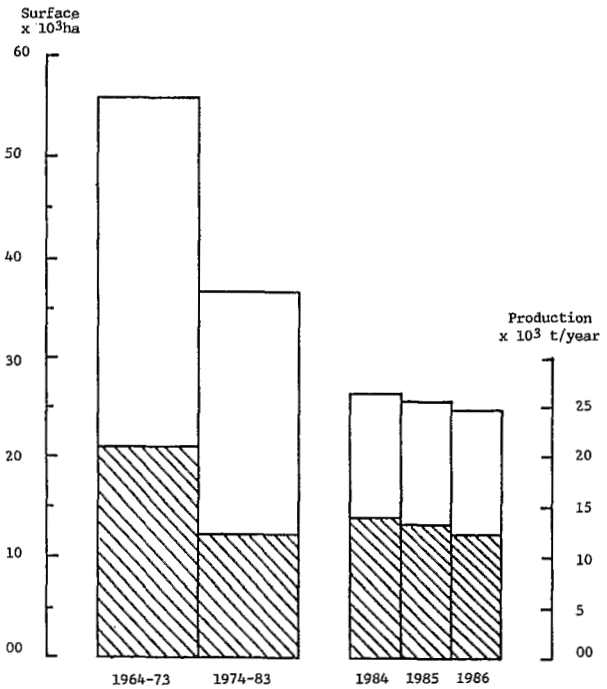

Fig. 1. Trends in the change of cultivated area and production of chickpeas in Portugal during the last 22 years.

Chickpea breeding work

In Portugal like in other Mediterranean and Latin American countries kabuli type varieties showing large ram-shaped and beige coloured seeds are widely preferred (Saxena, 1981). In contrast desi types are not grown at all in this country. However, some recent field results obtained at Elvas with some selected genetic material from ICRISAT and ICARDA, are encouraging enough to continue working on the introduction of well adapted desi genotpypes suitable for autumn sowing (Tavares de Sousa, personal communication). It is also important to get information about the food and feed quality of that crop under the agro-ecological conditions of the southern part of this country. Hence a breeding program on chickpea has been started at Elvas.

The major production constraints include (1) inherently low yield potential of the land races, (2) non advanced production techniques, (3) highly instable yield from year to year, (4) susceptibility to diseases and pests, (5) high cost of hand harvesting, (6) lack of suitable methods for mechanized harvesting, (7) high cost of cultivation, and (8) lack of suitable market organization. To overcome those constraints a crop improvement program is being carried out aiming at the development of cultivars having increased seed yield as well as yield stability; resistance to biotic stresses: common diseases (first, ascochyta blight), pests and *Orobanche*; resistance to abiotic stresses (temperature, moisture); growth characters suitable for mechanized harvest and acceptable or improved nutritive value and cooking quality of seed.

In addition, research on development of appropriate production agronomy, on physiology and on other related scientific disciplines is being carried out to support the breeding work.

To achieve its objectives the chickpea improvement program has organized three specific and complementary projects. The two projects are carried out at Elvas (National Plant Breeding Station) and Oeiras (National Station for Agricultural Research) involving production agronomy and breeding activities. Research on nutritional value is carried out in the third project at Fonte Boa (National Station for Animal Research). It should be added that the constitution of an efficient and diversified team of scientists was not yet possible for the lack of well-trained scientists, but major leadership is provided by Manuel Tavares de Sousa at Elvas, by Andre Dordio at Oeiras and by J. Ramalho Ribeiro at Fonte Boa.

Quite pragmatic and adaptative research based mainly on the philosophy and genetic material sent from the Food Legume Improvement Program (FLIP), ICARDA is carried out in those three institutions. The most promising advanced lines and interesting genotypes have been selected from the International Nurseries and Yield Trials received from ICARDA.

The strategy followed for the development of new cultivars and production techniques using the available genetic material involves the following:

Firstly, field experiments are conducted to isolate few well adapted and useful genotypes or advanced lines from the introduced material. At Elvas, artificial inoculation is done with the common diseases to improve the disease resistance in the selected varieties. Secondly, the selected genetic material, together with local check varieties, is evaluated at several locations showing different agro-ecological conditions. At Elvas, in 1988 some crosses were also done to increase the genetic variation in the material for selection. Thirdly, the most promising lines are tested in some field experiments and in a few farmers' fields, according to the principles of 'On-Farm Research' using recommended production technology. Also seed multiplication activities are simultaneously started and the nutritional quality is tested. At the same time, efforts are made to increase the international cooperation with FLIP, ICARDA and the national programs of Spain, France, Italy, Tunisia, Morocco and other Mediterranean countries. Cooperation with ICRISAT is also being developed.

Table 1. Performance of some promising chickpea introductions from ICARDA at Oeries, Portugal (unpublished data of Dordio, 1988, personal communication).

Year	Line	Yield		Remarks
		kg/ha	% of local check	
1984/85	FLIP 81-59W	2780	362	Low susceptibility to ascochyta blight and *Botrytis*
	FLIP 81-293C	2607	339	
	Local check	768	100	Highly susceptible to ascochyta blight
1986/87	FLIP 85-48C	3371	439	
	FLIP 85-86	3029	394	
	Local check	1171	100	
	ILC 195	2485	217	Attacks of *Fusarium* spp and *Sitona lineatus* were observed
	FLIP 84x182C	2314	202	
	Local check	1143	100	

Achievements and prospects

Capitalizing on the methodology and advances achieved by FLIP, ICARDA and ICRISAT and using the local experience, the Portuguese breeders have identified well adapted, high yielding genetic material from the international nurseries of the segregating populations and yield trials. Moreover, the program has well demonstrated the success of switching chickpea sowing to autumn from the normal spring-sowing as has been pointed out by Saxena (1981).

Since 1984, field experiments were carried out by Dordio at Oeiras and other locations. The grain yields of well adapted genotypes was higher when planted in autumn than in spring. According to Dordio (personal communication) the chickpea lines that have shown promising response in his experiments are indicated in Table 1.

Since 1985, at Elvas, chickpea breeding and agronomic research has started under the leadership of Tavares de Sousa. From the beginning, emphasis was laid on winter crop. The breeding methodology adopted follows the principles of self-pollinated species and agronomic research is directed to identify the appropriate technology in order to exploit the genetic potential of the genotypes identified for winter sowing. Work on kabuli chickpea is given higher priority and emphasis is on large seed suitable for food. Work on desi types is done on a smaller scale with the aim of developing material for animal feeding.

For autumn sowing of chickpea, resistance to *Ascochyta rabiei* is a pre-requisite and the success of the project depends decisively on the skill and screening techniques used in selecting resistant genotypes. Therefore, field and laboratory screening for resistance is routinely done. Data from segregating populations, international nurseries and yield trials and the germplasm of the national program are providing useful information to the breeders as well as the phytopathologist. Some efforts are devoted to improve the screening techniques. All the experimental chickpea plots located at Elvas are systematically innoculated artificially using a mixture of isolates collected from infected individual plants found in farmers' fields.

Phytopathology research will be further strengthened in cooperation with ICARDA, and the national programs in Spain and Rome, Italy.

The weather conditions during May and June 1988 in the chickpea growing areas were extremely favourable for the development of ascochyta blight epidemics as well as other pathogens like *Botrytis* spp. and *Sclerotium rolfsii*. The observations made this year were, therefore, of great value for disease resistance breeding. Until now resistance to *Ascochyta rabiei* in the Portuguese chickpea germplasm has not been found. However, a few ICARDA lines have shown good resistance as shown in unpublished data of M.T. Carvalho in Table 2.

Table 2. Winter chickpea lines showing resistance to *Ascochyta rabiei* at Elvas, field observations during 1988, (unpublished data of m.t. carvalho).

Elvas plot No.	Origin	Reaction[a]	Remarks
ChK 309	FLIP 83-15C	3-4	All these lines have also shown resistance in 1986/1987 experiments at Elvas.
ChD 319	ICC 5035-India	3	
ChK 372	FLIP 81-168C	3	
ChK 594	FLIP 85-83C	3	
ChK 621	FLIP 85-122C	2	
ChK 614	FLIP 85-102C	2	
ChK 598	FLIP 85-87C	2-3	
ChK 603	FLIP 85-88C	3	

[a]/ Reaction to ascochyta blight rated on 1 to 9 scale.

Following the classical breeding methodology for self-pollinated crops, Tavares de Sousa is leading a research project aiming at selection of high yielding and stable chickpea varieties suitable for sowing in winter. Basically, all the genetic material at different breeding stages

Table 3. Field results of the performance of some well-adapted small seeded chickpea lines at Elvas (unpublished data of M. Tavares de Sousa).

Elvas plot No.	Origin	1986/87				1987/88 reaction to	
		No. of Sow-Mat	AB[a] reaction	100 Seed weight (g)	Grain (kg/ha)	AB[a]	BOT[b]
Chk 309	FLIP 83 15C	214	2	33	2970	4	3
ChD 319	ICC 5035	207	2	26	3208	3	3
ChD 322	ICC 6304	207	3	27	3049	4	3
ChD 323	ICC 6306	207	2	26	3138	3	3
Standard 1	ILC 263	214	7	35	1206	8	8
Standard 2	ILC 482	207	3	32	2964	4	4
Chk 344	FLIP 84 71C	217	1	33	3120	3	4
Chk 348	FLIP 84 80C	212	1	38	3008	1	4
Chk 339	FLIP 84 60C	212	1	32	3012	3	3
Chk 362	FLIP 84 124C	-	1	32	2861	3	3
Chk 372	FLIP 84 168C	-	1	31	2793	3	3
Chk 354	FLIP 84 111C	-	1	25	2748	4	4
Chk 343	FLIP 84 70C	-	1	36	2745	3	4

[a]/ AB: Ascochyta blight reaction on 1-9 scale; 1 = no disease; 9 = very severe disease infestation leading to complete kill.
[b]/ Bot: *Botrytis* gray mould reaction on 1-9 scale similar to AB scale.

Table 4. Field results of the performance of some well-adapted large seeded chickpea lines at Elvas (unpublished data of M. Tavares de Sousa).

Elvas plot No.	Origin	No. of days Sow-Mat	1986/87			1987/88 reaction to		Remarks
			AB[a] reaction	100 Seed weight (g)	Grain (kg/ha)	AB[a]	BOT[b]	
Chk 504	FLIP 84 15	212	1	47	2877	8	8	Eliminated
Chk 503	FLIP 84 12C	212	1	41	2652	4	7	?
Chk 513	FLIP 83 56C	212	1	47	2630	5	4	Eliminated
Chk 512	FLIP 85 55C	212	1	49	2570	4	6	?
Chk 501	FLIP 83 77C	214	2	44	2542	4	7	?
Chk 510	FLIP 85 17C	212	1	49	2519	4	4	Selected
Chk 508	FLIP 85 5C	214	1	56	2478	6	7	Eliminated
Chk 511	FLIP 85 54C	212	1	48	2360	4	2	Selected
Chk 506	FLIP 84 19C	212	1	52	2336	6	5	Eliminated
L. check (cv. Gordo Portugal)		217	7	54	896	–	–	

[a]/ AB: Ascochyta blight reaction on 1-9 scale; 1 = no disease; 9 = very severe disease infestation leading to complete kill.
[b]/ Bot: *Botrytis* gray mould reaction on 1-9 scale similar to AB scale.

was derived from that sent from FLIP, ICARDA. A few promising advanced lines both for small seeds and large seeds are being tested in a multi-location system, including Elvas, as shown in Tables 3 and 4 (Tavares de Sousa, unpublished data).

The local land races show very high susceptibility to ascochyta blight when sown in autumn, have poor to medium grain yielding capacity, and are non-suitable for mechanized harvest. But the shape, colour and cooking quality of their grain are very good. Hence, in the spring season of 1988, a few crosses were made by Tavares de Sousa including some well adapted genotypes from ICARDA and the local land races, in order to combine economic traits from the two sources. The F_1 seeds obtained will be planted next autumn and the segregants will be studied and the material further carried using a compromise between the bulk and the pedigree method.

Some on-farm research activities have been developed by Tavares de Sousa in cooperation with the farmers and some promising results have been obtained. Winter chickpea production under farmer conditions has shown interesting possibilities through this research.

As a results of breeding work at Oeiras and Elvas some seed multiplication of promising lines of winter type chickpea has been started.

Nutritional quality is being investigated at the National Station for Animal Research at Fonte Boa under the leadership of Dr. J. Ramalho Ribeiro. The chemical analyses done in some desi and kabuli lines selected at Elvas showed good potentiality of the selected lines for nutritional purposes as they can also be used in feed grain industry. More results on this subject have presented by Dr. J. Ramalho Ribeiro himself in this Symposium.

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