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in

Saxena M.C. (ed.), Cubero J.I. (ed.), Wery J. (ed.).
Present status and future prospects of chickpea crop production and improvement in the Mediterranean countries

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 9

1990
pages 157-161

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SUMMARY - Chickpea breeding began in Madrid almost thirty years ago and then continued in Córdoba (Andalucía). Studies on quatitative genetics, including yield and seed quality components, as well as others aimed at the evolution of *Cicer arietinum* as a cultivated species have been performed. Four cultivars have been registered, two of them derived from Spanish landraces, the other two being reselections of two ICARDA lines. New cultivars derived from crosses between Spanish, ICARDA and ICRISAT lines are currently being obtained. Wilt, root-rot and virus attacks seem to be their most important constraints from a biological point of view. However, the most important factors explaining the decrease in chickpea cultivated area are non-biological ones such as importation of chickpea from Mexico, migration of rural population to urban areas etc. The use of chickpea for animal feeding would allow for an increase in the cultivated area.

RESUME - "La sélection du pois chiche en Espagne". La sélection du pois chiche commença à Madrid il y a environ trente ans, puis se poursuivit à Cordoue (Andalousie). Nous avons réalisé des études de génétique quantitative sur les composantes du rendement et de la qualité des semences, ainsi que des études sur l'évolution de Cicer arietinum *en tant qu'espèce cultivée. Quatre cultivars ont été inscrits au catalogue, deux d'entre-eux provenant de populations espagnoles, et les deux autres de lignées ICARDA. De nouveaux cultivars issus de croisements entre des lignées provenant d'Espagne, de l'ICARDA ou de l'ICRISAT sont en cours de sélection. Le flétrissement, la pourriture des racines et les virus semblent être les principaux facteurs biologiques limitant leur rendement. Cependant, les facteurs les plus importants à l'origine du déclin de la superficie cultivée en pois chiche sont d'origine non biologique: importation de pois chiche mexicain, migration de la population rurale vers les villes, etc. L'utilisation du pois chiche pour l'alimentation animale devrait permettre un renouveau de cette culture.*

Introduction

Chickpea is the second most important cultivated grain legume in Spain, common beans (*Phaseolus vulgaris* L.) being the first one. Fig. 1 shows both the cultivated area and yield since 1961. The area has decreased unceasingly throughout this period with a lowest value of about 85,000 - 90,000 ha having been reached in the last few years. Yield has been rather constant with a small tendency to increase during recent years. Fig. 2 shows the main chickpea producing areas in Spain between 1967 and 1985. The trend for a reduction of the area can easily be perceived.

Different causes explaining this situation can be mentioned. Amongst these, importation of chickpea from Mexico ranks first. These importations are maintained for political reasons as neither cultural nor agricultural aspects justify this policy. Farmers from the most typical chickpea areas in Spain have frequently pointed to this importation of Mexican chickpeas as the most important factor causing a reduction in chickpea cultivation in our country. Table 1 shows the importance of these importantions in relation to the national production.

A second non-technical factor must be mentioned. Early in the sixties, the policy makers decided not to support any research on grain legumes based on the low import price of soybean at that time in the international

Table 1. Spanish chickpea trade (in metric tons).

Years	Importation	Exportation	National production
1975	30375	146	56300
1976	31928	249	55000
1977	28538	473	55800
1978	55874	2622	71000
1979	46986	5304	64700
1980	27388	2667	60700
1981	43204	388	33200
1982	43366	719	47100
1983	32935	1377	49400
1984	26669	225	61900
1985	25964	811	57300

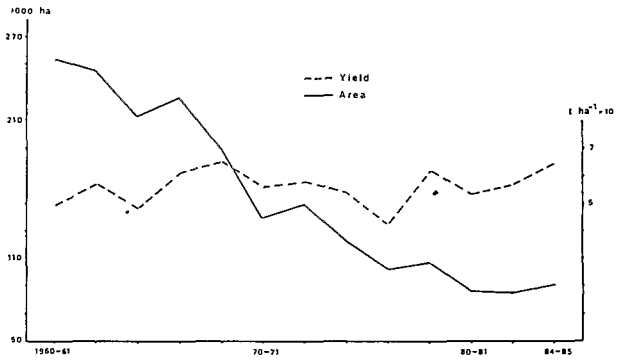

Fig. 1. Evolution of the cultivated area and yield of *Cicer arietinum* in Spain.

market. When both the energy and the soybean crisis started in 1973 only one group was working on grain legumes research in the whole country. The first attempts to organize research on pulses at the national level began in 1979 when not only most of the landraces had disappeared, but the important germplasm collections formed and maintained by Puerta and later on by his colleagues till 1970 had been abandoned or lost.

Finally, to complete the picture on the influence of non-technical factors on the reduction of chickpea production in Spain, the migration of the population from rural to urban and coastal areas must also be considered. These migrations, still active, had their peak some twenty years ago when most of the areas under traditional Mediterranean farming were getting quickly abandoned. Chickpea, especially for animal feeding, had been a typical crop in these areas.

There have also been some technical reasons, although in our opinion, these have not been decisive factors in explaining the steady decline of the chickpea cultivated area. *Ascochyta* blight attacks were traditionally considered the limiting factor for chickpea culture. However, in the early sixties several fungicides were found effective in controlling the disease. When the chick-

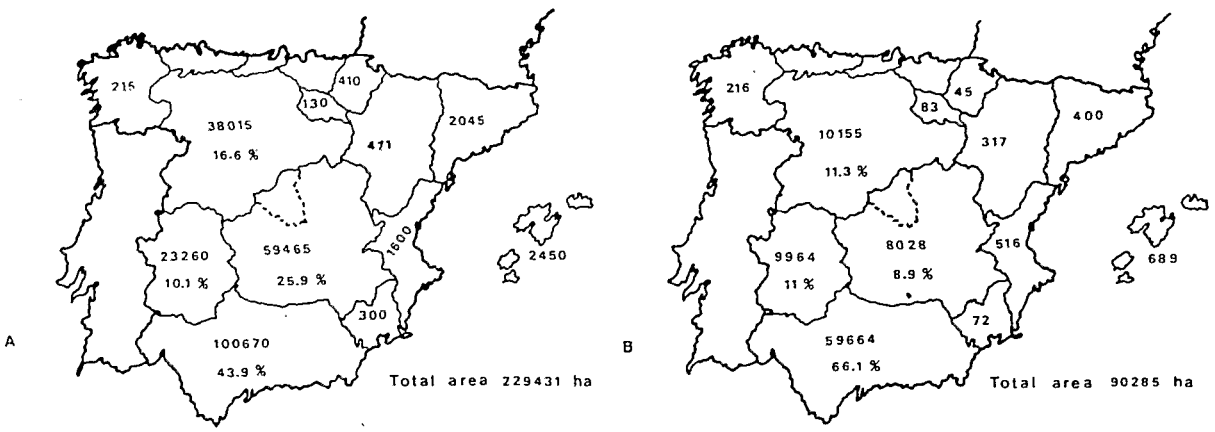

Fig. 2. Chickpea cultivated area in Spain in 1967 (A) and 1985 (B).

pea cultivated area was reduced to the most suitable lands for its culture, *Fusarium* spp. (and most probably other associated fungi such as *Rhizoctonia* spp. etc) became the most serious causes of diseases. Resistant cultivars were the only solution and there was, and still is, quite a bit of active research being carried out on this subject. The recent introduction of winter chickpeas has provided a second kind of control on these latter diseases as the winter sown crop is not attacked as often as traditional spring crop. Virus attack can become a serious menace in the near future. Resistant cultivars seem to be the only solution. Among insects, leafminer (*Lyriomiza cicerina*) was never considered to be a serious constraint, yet its real importance in Spain remains unknown. *Bruchus* was a serious store pest, but its control is now well-known. Other diseases and pests (rust, *Heliothis* spp., etc) are sporadic and of very minor importance.

Low yields have also been advocated as one of the main factors to explain the decreasing importance of pulses, in general, and of chickpeas in particular. Of course, low yield is only the results of a lack of the appropriate technology. Simply by using rational systems of cultivation, some farmers have been able to double their yields, even with their traditional landraces. The use of winter chickpeas can give four times more yield than the traditional spring sown crop. The lack of an adequate transfer of technology from research institutions to farmers is the primary cause of low yield and if latter is the cause of reduction in the cultivated area of chickpea this problem will have to be quickly and effectively addressed to.

Be that as it may, the present situation of chickpeas in Spain can be summarized as follows: the cultivated area is very much reduced in comparison with its traditional value; chickpeas are no more used for animal feeding; interest in chickpeas for human consumption has increased, and excellent culinary quality is demanded whose market price has reached very high values; interest in winter chickpeas is increasing because of high yields and; its introduction is considered desirable also for production of adequate animal feed; the major factor limiting an increase in the cultivated area of chickpea is the chickpea importation from Mexico, which from a technical point of view is unjustified.

Past and present of chickpea breeding

Systematic breeding was first started in the late fifties, when Puerta-Romero led a program on this and other food legumes in the Instituto Nacional de Investigaciones Agronomicas (INIA) in Madrid. Germplasm collections were established after several expeditions covering the whole country. The main factors limiting yield at that time were detected and selection schemes for chickpeas for human consumption as well as animal feeding were set up. A notable effort was devoted to *Ascochyta* blight (Puerta, 1964; Cubero, 1985, 1981).

Unfortunately the team was disbanded at the end of the sixties. A small portion of Puerta's collection as well as a fraction of the whole program was brought by Cubero to Cordoba in 1970. However, breeding was only restarted in 1975 under the pressure of several farmers who had already noticed the economic interest of good quality chickpeas for human consumption. The screening preformed at that time detected wilt/root rot caused by *Fusarium* spp. as the main problem, at least in south-west Spain (Cubero, 1975, 1980). Even though only a small collection had been kept, some lines showed resistance to the wilt/root-rot complex. The possibility of increasing traditional low yield through the use of adequate agricultural techniques was also pointed out.

Collaborative work was started with ICRISAT, looking especially for resistance to *Fusarium* spp. The program on *Fusarium* spp. resistance has been performed in collaboration with Professor Jimenez-Diaz, who was in charge of its phytopathological aspects. Collaboration with ICARDA started in 1978, following previous connections with ALAD. ICARDA has since provided germplasm, breeding materials adaptes to Mediterranean conditions and trials for breeding and agronomy. As the focal point in Spain for ICARDA we introduced the new winter chickpea technology, developed by the Food Legume Improvement Program of that Center. Some of the best lines were registered and were also used as parents in our own breeding program. Agronomic research on winter chickpea technology was later on followed by Profesor Lopez- Bellido.

Our group has so far been the only one working on chickpea breeding in Spain apart from another rather small team in Seville.

Achievements in chickpea breeding

Research suffered from lack of adequate financial support till 1980. Since then, the only constraints have been the lack of physical facilities for off-season advancement of a generation to hasten the process of development of cultivars and the lack of staff assigned to chickpea breeding on a permanent or quasi-permanent basis. A fast turnover of students included in our chickpea improvement research work has not helped either.

The major studies and achievements can be summarized as follows:

A) Genetics. The inheritance of morphological characters and yield components were studied by using different parentals and two different quantitative analytical methods (diallel analysis and Cavalli-Sforza scaling test). As many as twenty characters were studied. Most of the

variation found was additive (Moreno, 1985; Moreno and Cubero, 1978; Gonzalez, 1979; Martinez *et al.*, 1979; Gonzalez *et al.*, 1985).

Protein content and acid detergent fibre inheritance was also studied by using segregating generation. Additive variation was still the most important component of total variation (Gonzalez *et. al.*, 1985; Kharrat, 1988).

The inheritance of chickpea resistance to races 0 and 5 of *Fusarium oxysporum*, the most important ones in the Guadalquivir Valley, is being currently studied in collaboration with Professor Jimenez-Diaz's group.

Quality factors such as cookability, water absorption ability, and protein and fibre content, are also being studied. The genetic control of both seed surface and color has shown to be extremely complex. These will be reviewed in connection with other seed quality factors.

B) Systematics and evolution. Taxonometric studies were performed on a set of 150 landraces chosen after a preliminary screening of the original Puerta collection. The characters explaining mos of the variation were both seed and pod size. Two groups, *macrosperma* and *microsperma,* were subsequently defined within the cultigen. After considering the geographical distribution, genetic correlations between characters, the quatitative genetics of some characters and the barriers to crossability, their origin and possible evolution as a cultivated species were analyzed (Moreno, 1985; Moreno and Cubero, 1978).

Barriers to crossability were studied by using lines from different geographical regions and botanical races. Crossability resulted to be only a consequence of particular genotypes, and was unrelated to both geographical and botanical distributions (Martinez *et al.*, 1979).

C) New cultivars. As a consequence of the screening and evaluation of collections and of selections within the best accessions four cultivars were sent for official registration. Two of these are for winter sowing, derived from ICARDA-ILC 72 and ILC 200 lines. ILC 72 derived 'Fardon' (Snooty) has shown excellent performance. It is presently an excellent cultivar because of its erect habit and seed characteristics as required by the Spanish market. As a parental in our breeding program it will be present in many second generation lines, combining its tolerance to cold and resistance to *Ascochyta* blight. Other parental lines currently used in our program are ICCL 81001, P 687 and JG 62, from ICRISAT, as sources of *Fusarium* resistance. New promising lines are under multiplication and on their way to registration.

The old and new chickpeas cultivars must now be tested in a joint official trial with the Red Andaluza de Experimentacion Agraria. This agency is responsible for the promotion of chickpeas and is a member of our group.

The future

Even if the importation of chickpeas from Mexico for human consumption does not stop, the chickpea cultivated are could increase to recover old losses if chickpeas were used for animal feeding. However, this entails two difficulties: firstly, the Spanish animal feed industry is mostly based on soybean meal even though there are neither theoretical nor practical reasons for not accepting chickpeas. Secondly, and related to the former, there is no significant offer of chickpea for animal feeding in Spain; given the great difference in prices for animal feeding and human consumption (three fold on the average, occassionally reaching even five fold), farmers are reluctant to sow chickpeas for animal feeding. However, these kinds of chickpeas could be sown in larger area where chickpeas for human consumption are of poor quality. Even in the traditional chickpeas belts, farmers could sow the crop for animal feeding provided they found cultivars with very high yields. We are working on this idea, even though its success relies more on an adequate agricultural policy and on a good extension service rather than on the work of plant breeders.

On purely technical grounds, breeders will have the challenge of making the chickpea yields more competitive with other crops, and stabilize them at that level by incorporating resistance to wilt and root rot complexes and very likely, virus attacks. A way to obtain two generations of the crop per year will ease the work not only because of its intrinsic gain in time but also because there would be more students willing to work on the genetic improvement of chickpeas.

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