Status of chickpea in the Mediterranean basin

Saxena M.C.

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M.C. SAXENA
FOOD LEGUME IMPROVEMENT PROGRAM
INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH
IN THE DRY AREAS (ICARDA)
P.O. BOX 5466, ALEPPO, SYRIA

SUMMARY - Chickpea being of Mediterranean origin has a special significance in the agriculture of the Mediterranean basin. It provides human food, animal feed and fodder and plays an important role in maintaining the productivity of the soil in the region. Mediterranean basin countries account for about 10% of global area and 12% of global production of chickpea. There has been a trend for increase in area and production of the crop in the region in last 5 years, but yields have not increased, although they are higher than the world average. Past neglect for research on the crop is mainly responsible for this. Scope for increasing area by replacement of fallow exists. Large productivity gains are possible by introducing winter sowing in place of traditional spring sowing. Research network has developed with international centers such as ICARDA, ICRISAT and CIHEAM playing major co-ordination role. Necessity for greater integration of inter- and intra-institutional teams in tackling the problems that constraint productivity is well recognized. The regional networking is poised for great success in increasing the productivity and yield stability of chickpea in the Mediterranean basin.

RESUME - "La culture du pois chiche dans le bassin méditerranéen." Le pois chiche, plante d'origine mediterranéenne, occupe une place importante dans l'agriculture du bassin méditerranéen. C'est une source d'aliment pour l'homme, de graines et de fourrage pour l'animal et il joue un rôle important dans le maintien de la productivité des sols de la région. Les pays méditerranéens représentent environ 10% de la surface et 12% de la production mondiale de pois chiche. Sur les 5 dernières années on observe une tendance à l'augmentation de la surface et de la production de cette culture dans la région, mais les rendements n'ont pas progressé bien qu'ils soient supérieurs à la moyenne mondiale. Ceci s'explique avant tout par la faiblesse de l'effort de recherche consacré à cette culture. Les surfaces pourraient augmenter en remplacement de la jachère. Des gains de productivité importants pourraient être réalisés en remplaçant le semis traditionnel de printemps par le semis d'hiver. Un réseau de recherche s'est mis en place, notamment grâce au rôle de coordination joué par les centres internationaux tels que ICARDA, ICRISAT et CIHEAM. Une plus grande intégration des recherches au sein d'équipes inter- et intra-institutionnelles est maintenant nécessaire pour résoudre les problèmes qui limitent la productivité. Un tel réseau régional ouvre de grandes perspectives pour l'augmentation de la productivité et la régularisation du rendement du pois chiche dans le bassin méditerranéen.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the earliest grain legumes to be domesticated by man in the Old World. It most probably originated in an area that comprised present-day south-eastern Turkey and adjoining northern Syria (van der Maesen, 1987). The Mediterranean origin of the crop imparts special significance to chickpea in the agriculture of the Mediterranean basin, where it has multiple functions in the traditional farming systems. Besides being an important source of human food and animal feed, the crop plays an important role in the maintenance of the soil fertility, particularly in the dry rain-fed areas.

The importance of the crop in human food stems from the fact that its seed has (1) high protein content (about 20%) with better true protein digestibility than some other legumes (e.g., 90.5% as against 62-68% for *Phaseolus vulgaris*), (2) hypocholesterolemic property (Bressani, 1975), (3) no hemagglutinating activity and (4) low antitrypsic activity (Liener, 1975). The aminoacid composition of chickpea protein complements well that of cereals and therefore chickpea and cereals are an integral part of several traditional food recipes common in the Mediterranean basin. The dry chickpea seeds and the wastes from milling factories are used as animal feed. The straw, although somewhat inferior nutritionally to that of lentil, serves as a valuable fodder for stall-feeding of livestock. The significance of chickpea in the cropping

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system of the dry rainfed areas of the Mediterranean basin is due to its ability to fix atmospheric nitrogen through symbiosis with *Rhizobium ciceri,* the fixation may exceed 70 kg N/ha (Saxena, 1988), and to leave the soil in a more productive state for the subsequent crop of cereals (ICARDA, 1981; Papastylianou, 1987).

This paper examines the current status and future prospects of chickpea production and research in the Mediterranean basin.

Mediterranean environment

The Mediterranean type of climate is characterized by hot, dry summer alternating with cool and wet winters. Although such a climate is found at middle latitudes (between 30-40°) in all continents, the largest single contiguous area experiencing this climate is in the Mediterranean basin covering parts of West Asia, North Africa and southern Europe. Depending on the proximity to sea, altitude and other geographical features, the thermal and rainfall regimes in this area show large variations (Harris, 1979).

Data on monthly mean maximum and mean minimum temperatures and monthly total rainfall for 16 different locations in the Mediterranean basin during the 1984/85 cropping season are shown in Fig. 1 to highlight the diversity of the environmental conditions. The sites in Fig. 1 range in latitude from 33.3°N (Merchuch, Morocco) to 43.37°N (Montpellier, France) and 43.4°N (Tosheva, Bulgaria) and in altitude from 35 m (Salerno, Italy) and 70 m (Larissa, Greece) to 860 m (Heimana, Turkey) and 1321 m (Karadj, Iran). In this study the total seasonal rainfall ranged from 273 mm (Laxia, Cyprus) and 283 mm (Larissa, Greece) to 720 mm (Salerno, Italy) and 736 mm (El-Ghab, Syria). Minimum temperatures dropped to well below 0°C at several intermediate- and high-elevation sites whereas at low elevation sites they remained above 0°C. The general climatic features are that temperatures start falling from September onward when rains set-in, dropping down to the lowest values in December/January and start rising again rapidly from March onward by which time most of the seasonal precipitation has already been received.

Chickpea in this region is traditionally grown as a rainfed spring sown crop, mainly on the soil moisture conserved during winter rains in areas with seasonal precipitation of about 400 mm. Sowing in spring exposes the crop to declining soil moisture and increasingly desiccating atmosphere and rising temperatures which limit the productivity of the crop.

Area, production and yield

FAO production year book shows that with global 9.87 million hectares (average 1984-86) sown to chickpea producing 6.98 million tonnes, it is the third most important pulse crop after dry beans (*Phaseolus vulgaris*) and dry peas (*Pisum sativum*). The statistics on area, production and yield of the crop in the countries around the Mediterranean sea in comparison to the global values are shown in Table 1. Seven countries in Africa, eight in Asia and five in Europe are included. They together account for about 1.06 million hectares of area (10.7% of the global value) and 0.87 million tonnes of production (12.5% of the global value) of chickpea. Although the figures for the Mediterranean basin are relatively small when compared to the global values, the chickpea remains the most important pulse crop for the West Asian and North African countries accounting for nearly 30% of the total area and production of pulses in this region.

Over a period from 1979-81 to 1984-86 the average production of chickpea in the Mediterranean basin countries rose by 26% and most of this increase came from an expansion of the area as the yield remained static over this period (Table 1). This contrasts with about 17% increase in the global production over the same period, coming from 3.6% increase in area and 11.5% increase in the yield. Therefore, the area in the Mediterranean basin under chickpea is increasing at a faster rate than the global area. Although the average yield in this region has not shown any sizeable increase, the yields are higher here than the global yields. Both these facts highlight the importance of the crop in the Mediterranean basin.

Turkey, Spain, Morocco, Algeria, Syria, Tunisia, Portugal, Italy, Egypt and Greece are the important chickpea producing countries in the Mediterranean basin listed in the decreasing order of the area under the crop (Table 1). Turkey stands out as the most important, accounting for nearly 40% of the total area and 50% of the total production of chickpea in the region. Over the period from 1979-81 to 1984-86, both area and production in Turkey have nearly doubled. Much of this increase has come from the replacement of fallow area by chickpea. Area has also increased in Algeria and Morocco, perhaps by the same process, replacement of fallow. There has, however, been reduction in area in Greece (60%), Tunisia (40%), Portugal (28%), Italy (28%), Syria (12%) and Spain (2%) over this time period. Part of the reason for this decrease has been the poor economics of the crop because of increase in harvest costs and lack of adequate mechanization.

With the exception of Egypt (where crop is grown with irrigation), Palestine and Lebanon (where area is rather small), Italy, Greece and Turkey, the yield level in the Mediterranean basin countries is less than 1 tonne/

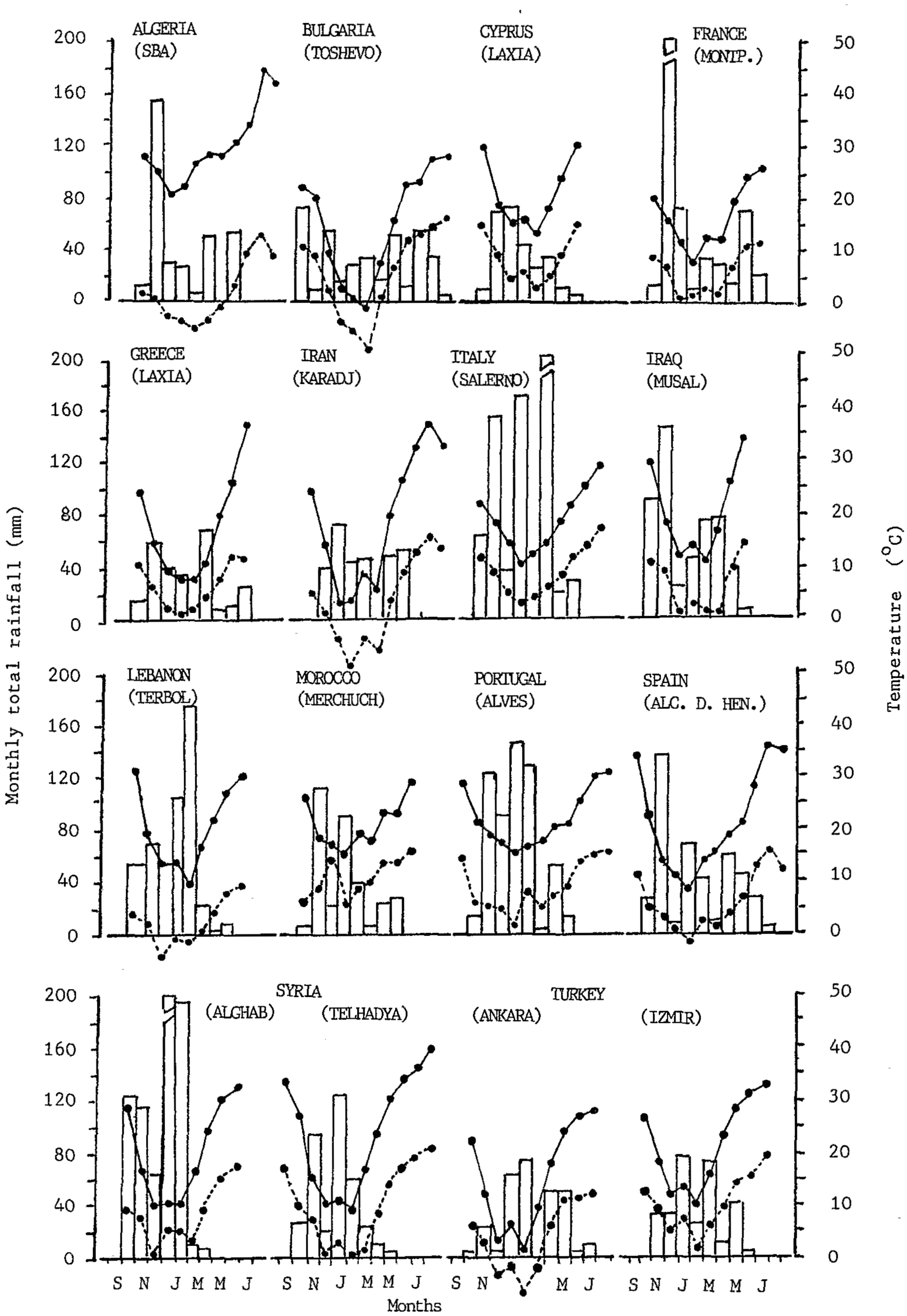

Fig. 1. Monthly mean maximum and mean minimum temperatures and monthly total rainfall during 1984/85 at various research sites in some countries around the Mediterranean basin.

ha. Yields are very low in Algeria and low in Portugal, Morocco, Spain, Syria and Tunisia (Table 1).

Table 1. Area (1000 ha), yield (kg/ha) and production (1000 metric tonnes) of chickpea in some countries in the Mediterranean basin and in the world.

	Area		Yield		Production	
Country	1979-81	1984-86	1979-81	1984-86	1979-81	1984-86
Algeria	42	58	392	263	16	15
Egypt	7	9	1538	1650	11	15
Ethiopia	152	178	829	709	128	126
Libya	1	1	669	693	< 1	< 1
Morocco	53	69	633	592	38	40
Sudan	2	1	1104	997	2	1
Tunisia	67	40	441	682	29	27
Cyprus	1	1	759	877	1	1
Iran	48	75	1092	702	52	53
Iraq	20	15	633	733	12	11
Jordan	2	2	601	515	1	2
Lebanon	2	1	1150	1145	3	1
Palestine	4	3	1300	1322	4	4
Syria	65	57	722	677	49	38
Turkey	213	415	1149	1058	245	445
Greece	15	6	1044	1100	15	6
Italy	14	10	1181	1242	16	13
Portugal	35	25	330	520	12	13
Spain	92	90	565	650	53	59
Yugoslavia	2	2	1013	983	2	2
Latin America	243	187	981	1069	244	200
Near East	361	577	1046	973	377	567
World	9530	9874	624	696	5972	6981

Source: Food and Agriculture Organization (FAO) (1987). 1986 FAO Production Yearbook Vol. 40, page 107, FAO, Rome.

Yield gap and factors responsible for low yields

An analysis of data in Table 1 shows that the average yield of chickpea in most of the major chickpea producing countries in the Mediterranean basin is rather low. A rough estimate of yield gap between the potential and the actual yield can be obtained from the examination of data in Table 2. Here the national yields for some major chickpea producing countries are compared with the actual yields obtained at some of the research sites during the 1984/85 season in the International Yield Trials conducted by the National Programs in co-operation with ICARDA. It has to be emphasized that the yield trials, although replicated, are small plot trials and can only give an approximate indication of the potential production at a site. One of the trials was conducted in the spring season (sowing between end of February and middle of April, depending on the site) and the other was winter sown (sowing between end of November to beginning of February). Both trials had 24 genotypes including one locally well adapted cultivar. Mean yield of all the 24 genotypes at each location as well as the maximun yield for that site are given in Table 2. It is clear that there is a very large gap between the yield in the experiments and the national average yield at all the locations except Turkey. The Heimana research station of Ankara was too dry a site for spring sowing (Fig. 1) and the experimental crop at the Izmir was partly damaged by the ascochyta blight, hence at both these locations the potential of the chickpea crop could not be satisfactorily demonstrated.

There are several factors that seem to constrain the productivity of chickpea in the Mediterranean basin. Although there are some constraints specific to a location, there are others which appear common to most sites. They can be categorized as environmental, agronomic and biotic.

Environmental constraints

These include the following:

1. Exposure of the spring sown crop to depleting soil moisture and increasing atmospheric drought during the reproductive growth.

2. Inadequate amount or unfavourable distribution of the rainfall.

Agronomic constraints

These include the following:

1. Use of land races and unimproved cultivars with low inherent yield potential and susceptibility to abiotic and biotic stresses.

2. Use of marginal lands.

3. Inadequate use of production inputs (fertilizer, pesticides, herbicides, supplemental irrigation, etc.) and production methods (land preparation, seeding, etc.).

Table 2. National average yield (1984-86) of chickpea as compared with the yield of some new genotypes tested in the International Yield Trials during the 1984/85 season at different locations in the Mediterranean basin (ICARDA, 1987).

Country	National average yield (kg/ha)	Yield (kg/ha) performance in the International Trials					
		CIYT - Spring			CIYT - Winter - Mediterranean		
		Location	Mean yield	Max. yield	Location	Mean yield	Max. yield
Algeria	263	Sidi B. Abbes	336	654	Sidi B. Abbes	1054	1467
Bulgaria	NA	Toshevo	2486	3000	–	–	–
Cyprus	877	–	–	–	Laxia	1733	2345
France	NA	Montpellier	2003	2495	Montpellier	2407	3148
Italy	1242	–	–	–	Perugia	4137	4311
Lebanon	1145	Terbol	1790	2141	Terbol	3118	4007
Morocco	592	–	–	–	Douyet	1213	1549
Portugal	520	–	–	–	Quinta	1882	2511
Spain	650	–	–	–	Cordoba	3851	5087
Syria	677	Tel Hadya	1338	1791	Tel Hadya	1699	2285
Tunisia	682	El-Kef	1471	2006	El-Kef	1795	2412
Turkey	1058	Ankara	422	605	Izmir	932	1272

NA = data not available.

Biotic constraints

These include depredation from:

1. Diseases: ascochyta blight, root-rot and wilt complex, stunt virus, root-knot and cyst nematodes, etc.
2. Insects: leaf-miner, pod-borer, etc.
3. Weeds.

There is a vicious circle that afflicts the productivity of chickpea in the region. Many constraints mentioned above operate because the crop has evolved over the years for low input agriculture and little research effort has gone into its improvement and for the development of more efficient production systems. With the relative economics of production being inferior to some other crops, particularly cereals, chickpea has been relegated to more marginal lands and the agronomic resources diverted to more profitable crops.

Prospects for improvement in production and productivity

Although there is a trend for increase in the production of the crop in the Mediterranean basin, the increase has not kept pace with the increase in the population so that the net availability per capita should have gone down. Further, there is a need for cheap source of good quality protein and calories for the production of compounded animal feed in the region. This can well be met by expanded production of chickpea with more competitive production economics.

In view of the above and also because of the importance of the crop in the maintenance of sustainable production of cereals and livestock in the dry land rainfed farming systems in the Mediterranean basin, it is important that efforts are made to improve the productivity of chickpea so that it may gain in economic competitiveness with other crops.

Fortunately, the recent cooperative research work done by the national programs in the region and by ICARDA/ICRISAT in collaboration with other institutions in the region promises large gains in the productivity of chickpea in the Mediterranean basin.

Productivity increases of more than 100% have been possible with the adoption of winter sowing of chickpea in contrast to the spring sowing traditional in the region. Data in Fig. 2 illustrate the yield response of chickpea to variations in sowing date from early spring at ICARDA in northern Syria. There is a linear decrease in the yield as the sowing is delayed from late November to middle of March. Similar responses to advancing the date of sowing have been obtained at several national program sites in the region where date of planting trials were conducted (Calcagno *et al.,* 1987; ICARDA, 1982, 1983, 1984, 1985, 1987; Sarno *et al.,* 1987; Saxena, 1984, 1987). Also the comparison of yields from the International Trials sown in spring with those from winter sown trials (e.g., Table 2) at various locations have substantiated the

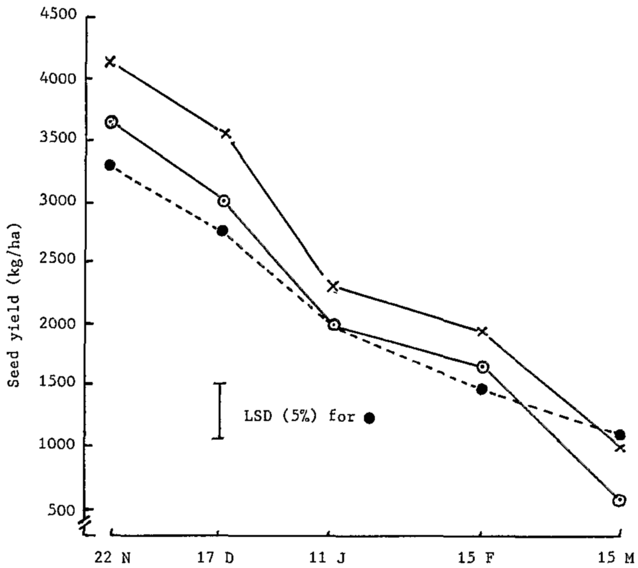

Fig. 2. Effect of date of sowing on the yield of NEC 293 (x--x) and ILC 190 (O —— O) chickpea cultivars and the mean yield of 20 cultivars (● - - - - ●) at Tel Hadya, northern Syria, 1978/79.

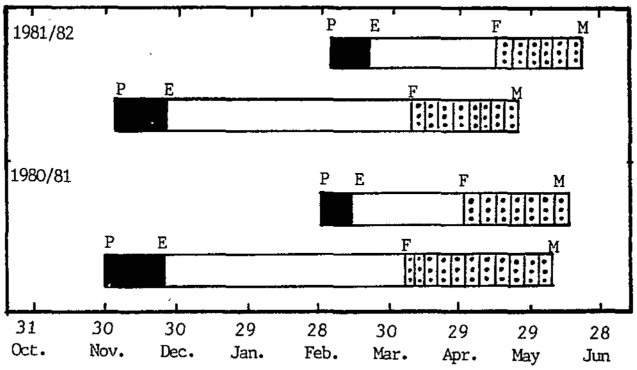

Fig. 3. Effect of date of sowing on the phenology of ILC 482 cultivar of chickpea at Tel Hadya, northern Syria, 1980/82. (P = sowing, E = emergence, F = flowering and M = maturity).

superiority of winter sowing over spring sowing (Hawtin and Singh, 1984; ICARDA, 1982, 1983, 1984, 1985, 1986, 1987).

The winter sowing permits matching of the chickpea crop phenology with the availability of optimun temperature and moisture regimes so that adverse effects of environmental conditions are minimized. Winter sowing, in contrast to spring sowing, permits expanded duration for vegetative growth (Fig. 3; also Iannelli and Bozzini, 1987), faster development of green area index (Cooper, 1983), and larger number of reproductive nodes. The total dry matter production is increased. The reproductive growth occurs in more favourable thermal and moisture regimes. Thus, the seed yield increases. Since the total water use of spring and winter sown crops remains nearly the same, there is substantial increase in the water use efficiency (Keatinge and Cooper, 1983).

For getting success with the winter sowing of chickpea it is necessary that the cultivars have high level of tolerance to cold and resistance to ascochyta blight (Saxena and Singh, 1987). Also the weeds have to be effectively controlled. Research on all these aspects has been underway in the national programs in the Mediterranean basin in cooperation with ICARDA/ICRISAT, and some of the countries have released cultivars for winter sowing. Suitable herbicides have been identified.

As the winter sowing results in increased water use efficiency, it is likely that it may lead to introduction of chickpea to non-traditional drier areas. Here, inoculation with suitable strains of chickpea *Rhizobium* will be necessary to optimize symbiotic nitrogen fixation. Research on this aspect has also been underway in the region. Also, newer problems such as those caused by root-knot and cyst nematodes and *Orobanche crenata* will have to be addressed to prevent the erosion of yield of winter sown chickpea.

Production increases of the traditional spring crop are also possible as is evident from the data from the International Yield Trials in different locations (Table 2). Genotypes with higher yield potential. And better tolerance to drought and high temperature, resistance to root-rot and wilt disease, resistance to leaf-miner and tall stature to facilitate mechanized harvest are being bred at ICARDA and in the cooperative programs with the national centers. Also research on supplemental irrigation, chemical weed control, phosphate fertilization and *Rhizobium* inoculation has given valuable results (Saxena, 1987; ICARDA, 1988) and package of production practices for different agroecological conditions are being developed.

Research networks and future research thrust

Multi-disciplinary research teams have developed in several national programs in the Mediterranean basin that are effectively interacting, in conducting joint research, with the international centers such as ICARDA, ICRISAT (International Crops Research Institute for Semi-Arid Tropics) and CIHEAM (Centre International de Hautes Etudes Agronomiques Mediterranéennes). Research groups have developed that specialize in tackling specific problems for the eventual benefit of all the countries in the Mediterranean basin. Some examples, by no means complete, are given below:

Ascochyta blight resistance: Tunisia, Turkey, ICARDA/ICRISAT.

Biological nitrogen fixation: France, ICARDA/ICRISAT.

Cold tolerance: Turkey, France, ICARDA/ICRISAT.

Drought tolerance: Morocco, France, ICARDA/ICRISAT.

Nematode resistance: Italy, ICARDA/ICRISAT.

Root-rot/wilt resistance: Tunisia, Spain, ICARDA/ICRISAT.

Wide-crossing and use of wild relatives and land races: Italy, Spain, ICARDA/ICRISAT.

Future research effort will have to be directed (1) to further increase the yield potential of the crop by developing plant type and production systems that enable better utilization of natural endowments of solar radiation, carbon dioxide and water, (2) to stabilize the yield by improved resistance to various biotic and abiotic stresses, and (3) to increase the beneficial effect of the crop for the cereals in cropping systems for eventual increase in the overall productivity and sustainability of the farming systems. Work will have to be done on crop modelling and identification of appropriate plant types for different agroecological situations, development of more efficient screening techniques for identification of sources of genes for tolerance/resistance to various biotic and abiotic stresses, understanding the physiological/biochemical basis for these reactions so that the resistance trait could be better used, and developing biotechnological tools for use of genes from distant relatives and wild species and for hastening the process of cultivar development. This basic and strategic research will have to go hand-in-hand with more applied aspects of evaluation of developed cultivars and production techniques on farmers' field, in the whole farming systems' context with adequate attention given to the socio-economic consideration. This will necessitate development of more integrated multi-disciplinary teams of agronomist, breeder, crop physiologist, entomologist, microbiologist, nutritionist, pathologist and social scientist. Environment for development of such teams in the Mediterranean basin countries exists and the fact that this seminar is taking place is a reflection of the determination of the scientists in this region to work closely to improve the productivity and yield stability of chickpea.

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