Winter chickpea: problems and potential in the Mediterranean region

Singh K.B.

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Winter chickpea: problems and potential in the Mediterranean region[1]

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

SUMMARY - The work on breeding of winter chickpea at ICARDA for the past ten years has been reviewed. More than 15,000 germplasm lines were screened and 18 lines were identified as resistant to ascochyta blight. On screening of 4500 lines to cold, 15 lines were found tolerant. All ascochyta blight resistant lines were susceptible to cold and all cold tolerant lines were susceptible to ascochyta blight. Lack of combined resistance in a line to both stresses appears to be the main reason for not cultivating chickpea during winter in the Mediterranean region. More than 800 ascochyta blight and cold tolerant high yielding lines have been bred and made available to national programmes. In each country of the Mediterranean region, superiority of winter chickpea over spring has been proven. National Agricultural Research Systems from eight countries have selected cultivars and released them for winter sowing. The economic analysis indicated that winter-sown chickpea is 60 to 70 percent more profitable than spring chickpea. If all areas in the Mediterranean region are brought under winter chickpea and a modest increase of 500 kg/ha is obtained over spring, the region will benefit by an additional production of 462,500 tonnes annually.

RESUME - "Pois chiche d'hiver: problèmes et potentiels pour la région méditerranéenne". Ce texte fait le bilan de la sélection du pois chiche pour le semis d'hiver au cours des 10 dernières années. Plus de 15.000 lignées ont été criblées et 18 d'entre-elles ont été identifiées comme résistantes à l'anthracnose. Parmis les 4.500 lignées criblées pour la résistance au froid, 15 se sont révélées tolérantes. Toutes les lignées résistantes à l'anthracnose étaient sensibles au froid et toutes celles qui résistaient au froid étaient sensibles à l'anthracnose. L'absence de combinaison de ces deux résistances dans les lignées explique probablement pourquoi le pois chiche n'est pas semé en hiver dans la région méditerranéenne. Plus de 800 lignées résistantes à l'anthracnose et au froid ont été créées et distribuées aux programmes nationaux. Dans tous les pays du bassin méditerranéen la supériorité du pois chiche d'hiver par rapport au pois chiche de printemps est maintenant établie. Les organismes de recherche de 8 pays ont sélectionné des cultivars et les développent pour le semis d'hiver. L'analyse économique indique que le pois chiche d'hiver donne un revenu 60 à 70% supérieur à celui du pois chiche de printemps. Si toutes les zones de production du pois chiche de la région méditerranéenne adoptaient le semis d'hiver, et en admettant une augmentation modeste de rendement de 500 kg/ha par rapport au semis de printemps, la région verrait sa production croître de 462.500 tonnes.

Introduction

Chickpea (*Cicer arietinum* L.) is grown as a spring-sown crop in the Mediterranean region, whereas other cool season food legumes, such as faba bean (*Vicia faba* L.), lentil (*Lens culinaris* L.) and pea (*Pisum sativum* L.), are grown as winter-sown crops. Research conducted at the International Center for Agricultural Research in the Dry Areas (ICARDA) has revealed causes for not growing chickpea as a winter-sown crop. This paper updates the progress made in breeding on winter chickpea and discusses its problems and potential in the Mediterranean region.

Brief literature review

An experiment conducted at the University of Aleppo Farm in Muslimieh, Syria during 1976/77 indicated that high yield was possible from the winter-sown chickpea provided ascochyta blight could be controlled (Hawtin, 1979). The same year, Singh and Hawtin (1979) reported the high yield potential of winter chickpea. Saxena (1980) studied the effect of a date of planting which indicated

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that very high yields could be obtained by autumn planting of chickpea as compared to spring planting. ICARDA organized a workshop on "Ascochyta Blight and Winter Sowing of Chickpeas" which summarized the results obtained until 1981 on all aspects of winter chickpea (Saxena and Singh, 1984). Singh and Malhotra (1984) have described the historical development of winter chickpea at ICARDA to 1983.

Ascochyta blight

Ascochyta blight caused by *Ascochyta rabiei* (Pass.) Lab. is the most serious disease of chickpea in the Mediterranean region, completely destroying the crop when it appears in the epiphytotic form. Nene (1984) has reviewed the work on this disease.

Screening technique

An easy and reliable screening technique for the field evaluation of large number of germplasm and breeding lines was developed at ICARDA (Singh *et al.*, 1981). In brief, it comprises (a) planting susceptible chickpea at frequent interval and all around the nursery plot, (b) inoculating the nursery with diseased debris collected in the previous season, (c) providing sprinkler irrigation to raise the relative humidity, and (d) reinoculating the nursery with spore suspension prepared in the laboratory for uniform development and spread of disease.

Evaluation of germplasm

Between 1978 and 1988, 15,310 germplasm lines have been evaluated using a 1-9 scale (Singh *et al.*, 1981) (Table 1). Fifteen lines, including 12 kabuli and 3 desi, have been found resistant. All lines are late and have intermediate type seed of small size (19 to 27g per 100 seed), mid-tall to tall plant type, and low yield potential (Table 2).

Inheritance of resistance to ascochyta blight

The inheritance of resistance to ascochyta blight in resistant lines is governed by a single dominant or recessive gene (Acikgoz, 1983; Eser, 1979; Hafiz and Ashraf, 1953; Singh and Reddy, 1983; Singh and Reddy, 1988; Tewari and Pandey, 1986; Vir *et al.*, 1975). In one of our unpublished studies, we observed that, besides a major gene, some minor genes or modifiers contribute to the inheritance of resistance and that more than one major gene was responsible for inheritance of resistance.

Table 1. Reaction of chickpea germplasm to ascochyta bligth at Tel Hadya, 1978-88.

Blight reaction	Accession No.		Total No.	Percent of total
	Kabuli	Desi		
R	12	3	15	0.10
MR	17	13	30	0.20
T	55	76	131	0.86
MS	1453	1539	2992	19.54
S	3570	8572	12142	79.30
Total	5107	10203	15310	100.00

R = Resistant; MR = Moderately resistant; T = Tolerant; MS = Moderately susceptible; S = Susceptible.

Table 2. Some characteristics of ascochyta blight resistant kabuli germplasm lines against a mixture of races 1, 2, 3, and 4 at Tel Hadya, Syria.

Line	Origin	Blight reaction[a]	Maturity	Seed type	100-seed wt (g)	Pl.ht. (cm)	Yield
ILC 182	USSR	3	Late	I[b]	19	50	Low
ILC 200	USSR	3	Late	I	19	57	Low
ILC 2506	USSR	3	Late	I	22	71	Low
ILC 2956	USSR	3	Late	I	27	76	Low
ILC 3274	USSR	3	Late	I	24	71	Low
ILC 3856	USSR via Morocco	3	Late	I	20	65	Low
ILC 3866	Bulgaria	3	Late	I	23	65	Low
ILC 3870	Bulgaria	3	Late	I	23	65	Low
ILC 4421	USSR	3	Late	I	19	57	Low
ILC 5586	USSR via France	3	Late	I	22	52	Low
ILC 5921	Bulgaria	3	Late	I	22	56	Low
ILC 6188	USSR via France	3	Late	I	24	77	Low

a/ Blight reaction: 1 = Free, 3 = Resistant, 5 = Tolerant, 7 = Susceptible, 9 = Killed.
b/ I = Intermediate type.

The major problem in breeding for blight resistance is the presence of numerous races of *A. rabiei*. We are breeding lines resistant to four races. It is difficult to breed lines resistant to all races because resistance to different races are not available in a single genotype. We are pyramiding genes for resistance to different races and also exploiting wild species, some of them are free from blight damage.

Cold

Winter planting of chickpea in the Mediterranean region is only successful with cold tolerant cultivars. Plant losses during the winter are usually due to freezing injury. Limited studies on cold tolerance in chickpea have been made (Singh *et al.*, 1981; Singh *et al.*, 1984). Recently, Singh *et al.* (1988) reported a comprehensive study on screening germplasm for cold tolerance. Some information from this paper and other studies is reported here.

Screening technique

A field screening technique has been developed at ICARDA which includes: (a) planting chickpea in early October and growing the crop to the late vegetative stage before the on set of severe winter and (b) planting susceptible-cum-indicator rows at frequent intervals in the cold nursery and evaluating germplasm and breeding lines after the death of susceptible check due to cold.

Evaluation of germplasm

Between 1981 and 1988, 4532 germplasm lines have been screened using a 1-9 scale, and 15 lines identified tolerant (Table 3). Lines found tolerant of cold are listed in Table 4. Growth habit, time to maturity, leaf size, and plant height had no association with cold tolerance.

Other studies

Inheritance of tolerance to cold was studied in six resistant lines. The tolerance was dominant over susceptibility. But it seems that cold tolerance is governed by polygenes. The effect of depth of planting on cold tolerance was studied by placing seed at 5, 10, 15, and 20cm deep in one resistant and one susceptible cultivar. Depth of planting had no effect on winter kill of chickpea.

Screening for cold tolerance has been a difficult problem. We have not been able to decide the level of cold at which the screening should be done. From a practical point of view, our screening is confined to the lowest temperatures of -6 to -10°C as this level of cold exists at Tel Hadya, Syria. If varieties tolerant to lower temperatures are required by any programme, then facilities may have to be developed.

Table 3. Reaction of chickpea germplasm lines to cold at Tel Hadya, Syria, 1981-1988.

Reaction to cold	(1981/82 to 1986/87)		(1987/88)[a]	
	Number of lines	% of total	Number of lines	% of total
Free	0	0.0	0	0.0
Highly tolerant	0	0.0	0	0.0
Tolerant	15	0.6	0	0.0
Moderately tolerant	58	2.3	38	1.9
Intermediate	558	22.1	77	3.8
Moderately susceptible	371	14.7	108	5.4
Susceptible	513	20.3	181	9.0
Highly susceptible	843	33.4	768	38.3
Killed	168	6.6	834	41.6
Total	2526	100.0	2006	100.0

a/ Needs confirmation for one more season.

Table 4. Origin, growth habit, leaf area, days to flower, plant height, and 100-seed weight of the cold tolerant (score of 3 on 1-9 scale) chickpea germplasm.

Line	Origin	Growth habit score[a]	Leaflet area cm^2	Days to flower days	Height cm	100-seed weight g
ILC 794	Iran	P	0.70	185	58	29
ILC 1071	Iran	SP	1.10	185	59	41
ILC 1251	Iran	SE	0.85	184	60	20
ILC 1256	AFG	SE	0.87	184	56	18
ILC 1444	AFG	SP	0.62	188	45	16
ILC 1455	AFG	P	0.77	180	50	26
ILC 1464	AFG	P	0.78	180	56	20
ILC 1875	India	SE	0.76	180	45	26
ILC 3465	Spain	SP	0.73	186	50	31
ILC 3598	India	SE	0.81	183	57	23
ILC 3746	Nepal	SP	0.59	180	50	10
ILC 3747	Nepal	P	0.67	180	45	9
ILC 3791	India	SE	0.73	180	60	28
ILC 3857	Morocco	SE	1.25	182	60	23
ILC 3861	Morocco	SP	1.05	185	60	27

a/ P = Prostrate; SP = Semi-prostrate; SE = Semi-erect.

Resistance to blight and cold

None of the germplasm lines were found resistant to both blight and cold. Lack of combined resistance in a line to both stresses appears to be the main reason for not cultivating chickpea during winter in the Mediterranean region. It is also believed that due to lack of resistance to these stresses all previous attempts to introduce chickpea for winter sowing would have failed.

Breeding winter chickpeas

Selection from germplasm

As a first step, we began evaluating the kabuli chickpea germplasm to ascochyta blight from 1977/78 and to cold from 1978/1979. Lines identified tolerant or with intermediate reaction to these two stresses were evaluated for yield at Tel Hadya, ICARDA's principal station in Syria and distributed in the form of Chickpea International Yield Trial-Winter (CIYT-W) to cooperators in the Mediterranean region since 1979/80.

Hybridization

The hybridization programme was initiated in the spring of 1978 to develop genetic stocks suited for winter sowing. Several breeding schemes have been tried and currently bulk-pedigree method is being used (Fig. 1).

The off-season site at Terbol, Lebanon located at an altitude of 980 m above sea level with irrigation has been used to (a) grow F_1 generation to produce F_2 seeds, (b) select for reduced photoperiod sensitivity in the F_3 and F_6/F_7 generations, and (c) increase seed of newly bulked lines. This has been a great asset in accelerating the pace of varietal development.

The 'bulk-pedigree method' helps in the early elimination of the material susceptible to ascochyta blight and sensitive to photoperiod. Progenies are systematically evaluated for reaction to cold, leaf miner, cyst nematode, and drought, and susceptible material is rejected. Protein content is monitored and lines with protein content less than the standard cultivar are discarded. Positive selection for plant height, maturity and seed size is made.

Advanced generations, F_5 and F_6, and preliminary yield trials are grown during both winter and spring, and selections are practiced in both seasons. Generally, the performance of lines is different in the two seasons. This is due to differences between the seasons in temperature, available moisture, photoperiod, length of growing period, disease and insect incidence. Consequently, the breeding for winter and spring chickpeas has to be handled separately.

Through hybridization, more than 800 blight and cold tolerant and high yielding lines with true kabuli seed type of medium size have been bred which meet the requirements of farmers and consumers. For example, the hundred seed weight of FLIP 85-4C and FLIP 83-115C are 46g and 41g, respectively. Another achievement of breeding has been the development of combined resistance to ascochyta blight and cold (Table 5). Lines with a range of maturity, plant height, and leaf types have been bred to meet the different needs of the National Agriculture Research Systems (NARS).

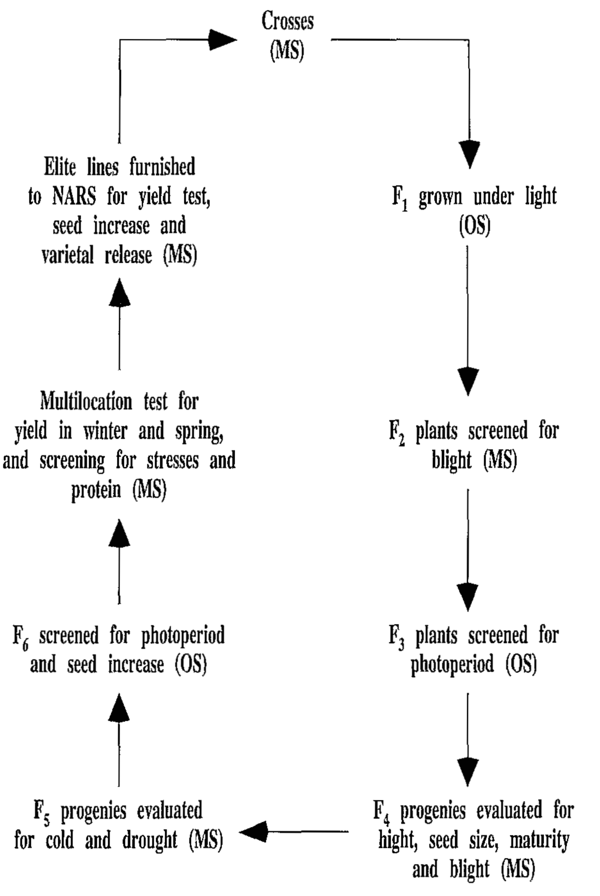

Fig. 1. Varietal development scheme in chickpea implemented by ICARDA and National Programs. OS = Off seasons; Ms = Main season.

Future cultivars should possess large seed size, tall stature, resistance to ascochyta blight and cold and yield potential of 4 t/ha. ICARDA chickpea programme is making effort in this direction.

Yield testing

Spring vs. winter comparison

Upon the availability of a large number of ascochyta blight and cold tolerant lines from the breeding programme, detailed comparisons were made for yield between winter and spring from 1982/83 to 1986/87 (Fig. 2). The superiority of winter sowing over spring sowing is evident from the fact that on average of four years and three locations and evaluation of at least 96 genotypes, the winter-sown trials produced 1,750 kg/ha compared to 1,153 kg/ha of spring. Hence, the superiority of winter

Table 5. Some of the breeding lines tolerant to ascochyta blight and cold developed at ICARDA, Syria.

Line	Reaction to	
	Ascochyta blight	Cold
FLIP 82- 97C	3	4
FLIP 82- 131C	4	3
FLIP 82- 150C	3	4
FLIP 83- 22C	3	4
FLIP 85- 4C	3	4
FLIP 85- 84C	4	4
FLIP 85- 87C	3	4
FLIP 85- 90C	4	4
FLIP 85- 133C	4	4
FLIP 85- 141C	4	4

Scale: 1 = free, 5 = intermediate, and 9 = killed.

sowing over spring was sufficiently demonstrated. It may be pointed out that each year different sets of 96 genotypes were evaluated.

International yield trial

The first international yield trial was conducted jointly by ICARDA and NARSs during 1979/80. This trial proved that winter sowing was possible throughout the Mediterranean region and demonstrated that very high yield, in excess of 3t/ha, can be obtained by winter sowing. Results obtained during 1985/86 confirmed the finding of the first year (Table 6). It also suggested that yields in excess of 7t/ha can be produced under favourable conditions. With this kind of high yield chickpea crop can be highly competitive and remunerative in the Mediterranean region. Differences in yield between 1979/80 and 1985/86 were partly due to better genotypes bred at ICARDA and partly due to better management. The first year trial included entries selected from germplasm and the trial during 1985/86 included entries bred at ICAR-

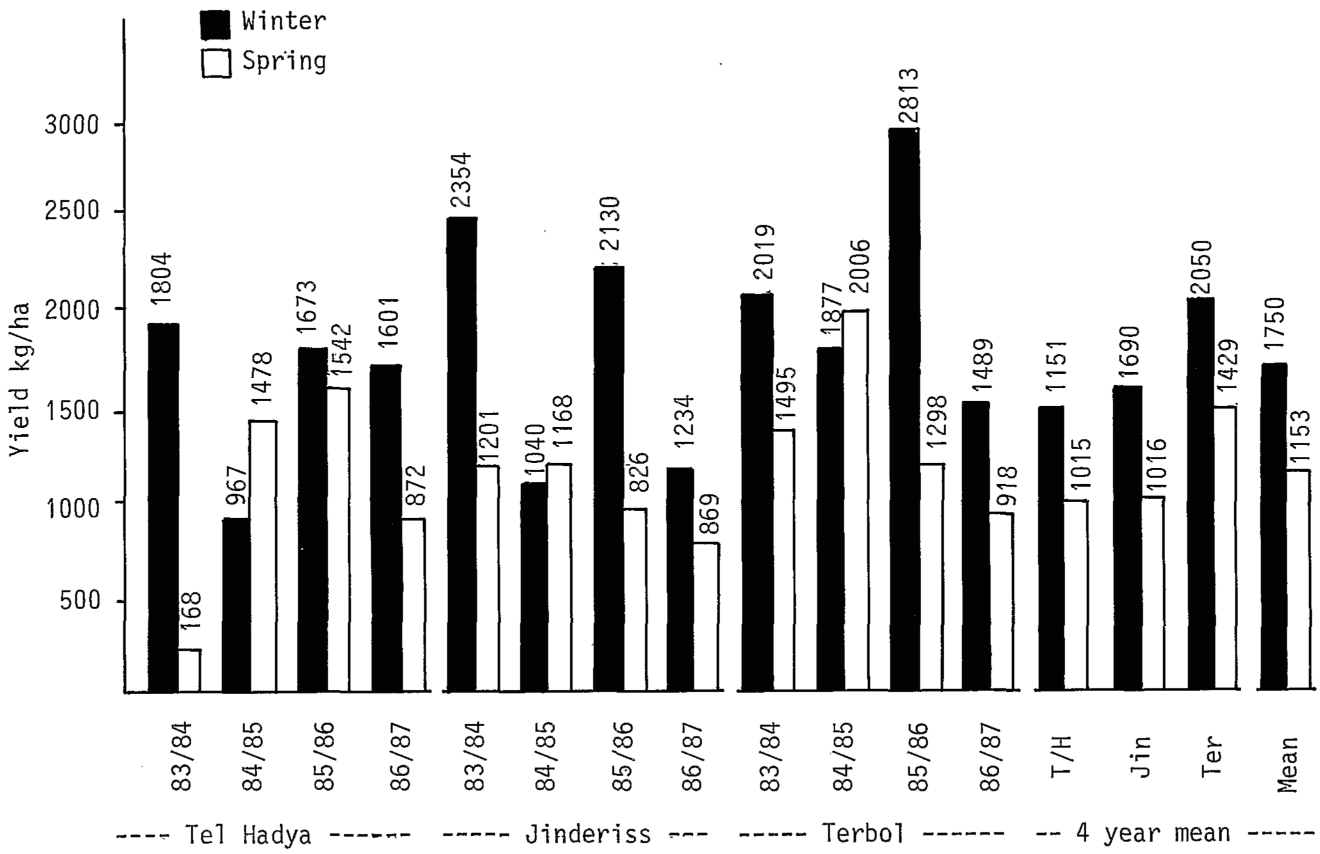

Fig. 2. Mean seed yield of 72, 96, 96, and 98 entries of chickpea grown during winter and spring in Syria and Lebanon.

Table 6. Seed yield (kg/ha) of entries from selected locations in the Chickpea International Yield Trial-Winter-Mediterranean Region (CIYT-W-MR) during 1985/86.

Entry name	ALGERIA Khroub	FRANCE Montpellier	GREECE Larissa	IRAQ Sulaimaniya	ITALY Metaponto	JORDAN Marow	LEBANON Terbol	MOROCCO Marchouch	PORTUGAL Elvas	SPAIN Cordoba	SYRIA Jableh	TUNISIA Beja	TURKEY Izmir	Overall Mean of 29 location
FLIP 81-293C	1511	2305	2631	1365	3845	1240	3111	2010	1270	1769	6310	2094	1494	2149
FLIP 82-101C	1206	588	2725	1313	3679	849	2984	1572	1294	1888	5595	2119	2119	2042
FLIP 82-115C	1256	1386	2325	1260	3845	793	2952	1923	1300	1459	5738	2194	1783	2040
FLIP 82-121C	1000	579	2156	1354	3655	892	2683	1788	1177	1828	4250	1869	2089	1906
FLIP 82-127C	1580	2700	2706	1115	3381	1152	3048	2701	1350	1566	5798	2413	906	2146
FLIP 82-128C	1117	2080	2838	1313	3940	1090	3202	1934	1404	1809	5024	2213	1486	2217
FLIP 82-138C	1307	319	2631	1260	3714	1038	2988	1747	1224	1669	5845	2225	1521	2004
FLIP 82-154C	1119	679	2313	1010	3583	810	3075	1798	1082	1622	5083	1425	1249	1844
FLIP 82-161C	1062	445	2481	979	3810	960	2865	2137	1175	1666	4821	2131	1775	1944
FLIP 82-169C	1582	950	2713	1292	3964	1310	3135	2418	1299	1925	5000	2213	1499	2135
FLIP 82-172C	1468	1015	2606	1146	3893	812	2770	1964	1307	1928	5190	1938	1721	1958
FLIP 82-186C	1414	340	2356	927	3560	957	2968	2035	1427	1356	5500	2044	1474	1979
FLIP 82-232C	1281	640	2825	1052	3595	1007	3020	2408	1217	1519	5012	2350	1563	2050
FLIP 83- 7C	1410	1817	2669	833	3536	958	2068	1915	1179	1716	5690	1881	1946	2012
FLIP 83- 41C	1297	471	2831	1052	4000	980	2841	1609	1281	1834	5000	2281	1654	1944
FLIP 83- 47C	1238	1271	2988	927	3738	1705	3131	2326	1223	1738	5357	2188	1627	2288
FLIP 83- 48C	1789	1058	3019	1156	3762	862	2829	2733	1333	1684	7714	2669	1728	2268
FLIP 83- 49C	1422	433	2103	896	4190	1051	3004	1900	1388	1894	5786	2319	1346	2137
FLIP 83- 71C	1164	1007	2763	1313	3929	1204	2881	2147	1192	1803	6512	2050	1721	2200
FLIP 83- 97C	1371	946	2625	760	3702	965	3060	2016	1119	1619	6190	2256	1847	2018
FLIP 83- 98C	1187	1220	2594	1115	3798	1248	3294	2038	1196	1763	5833	2531	1528	2252
ILC 482	1441	360	2338	1198	4202	1100	3187	2335	1627	1900	5548	2900	2306	2232
ILC 3279	1246	330	2131	844	3476	836	2833	1961	1143	1456	4750	1588	–	2846
Local check	1187	611	1488	–	3655	1013	3222	2095	1175	2084	5488	1194	–	–
Location mean	1319	981	2356	1108	3769	1035	3002	2063	1266	1729	5543	2128	1654	–
SE of mean	141	138	193	161	180	175	126	129	129	160	631	160	250	–
LSD at 5%	398	391	546	–	–	–	–	640	–	–	–	453	–	–
CV %	21	28	15	29	9	33.85	8	22	20	18	22	15	26	–

DA. Lines developed through hybridization programme were 30 percent superior to lines selected from germplasm.

On-farm trial

The Directorate of Scientific Agricultural Research of the Ministry of Agriculture and Agrarian Reform, Syria and ICARDA jointly initiated "scientist managed on-farm trial" in the 1979/80 season. The objective of this trial was to compare the performance of winter chickpea with that of spring chickpea at 18 locations throughout Syria. Winter chickpea produced more than 100 percent yield than spring chickpea and it was clear that the control of ascochyta blight is necessary for winter sowing (Table 7).

Based on results obtained from the on-farm trial, Syria has released two cultivars, 'Ghab 1' and 'Ghab 2'.

Release of cultivars for winter sowing

Based on superior performance of lines in seed yield, disease resistance and plant type, eight countries have released 18 cultivars for winter sowing from the ICARDA supplied germplasm (Table 8).

Table 7. Seed yield (y=kg/ha) and disease rating (dr) of cultivars sown during winter and spring of 1979/80 at farmers' fields and experiment stations in Syria.

Location	Winter				Spring	
	ILC 482		Syr. local		Syr. local	
	Y	DR[1]	Y	DR	Y	DR
Izra	1666	NA	1444	NA	793	NA
Gelline	1076	1	707	7	666	NA
Hama[2]	3427	NA	3093	NA	3190	NA
A village near Hama	1831	NA	1740	NA	816	NA
Homs	2833	1	1056	NA	1555	3
A village near Homs	2222	NA	1111	NA	1389	NA
Boustan El-Basha	1667	NA	0	9	0	9
Azes	836	2	501	2	401	3
Atareb	2110	1	701	7	477	3
Derkak	712	1	31	9	5	9
Ebben	1039	1	863	3	791	1
Kawkaba	1576	1	809	5	1674	1
Mohambel	1781	2	281	3	264	2
Maret Masrin	1417	1	706	5	1173	5
Breda	2481	NA	146	NA	104	NA
Jinderiss	2464	3	0	9	0	9
Kafarantoon	1357	NA	1638	NA	1658	NA
Tel Hadya	1971	3	0	9	605	5
Mean	1839		824		865	

1/ 1 = no disease; 9 = Complete kill; NA = Data not available.
2/ The trial at Hama was irrigated and protected by fungicide.

Table 8. Release of chickpea cultivars selected from international nurseries by national programs for winter sowing.

Country	Year of release	Cultivars released	Specific features
Algeria	1988	ILC 482	High yield, wide adaptation
	1988	ILC 3279	Tall type
Cyprus	1984	Yialousa (ILC 3279)	Tall type
	1987	Kyrenia (ILC 464)	Large-seeded type
Italy	1987	Sultano (ILC 3279)	Tall, resistant to cold and blight
	1987	Califfo (ILC 72)	Tall, resistant to cold and blight
Morocco	1987	ILC 195	Tall type
	1987	ILC 482	High yield, wide adaptation
Spain	1985	Fardón (ILC 72)	Tall type, high yield
	1985	Zegrí (ILC 200)	Med-tall, high yield
	1985	Almena (ILC 2548)	Tall, high yield
	1985	Alcazaba (ILC 2555)	Tall, high yield
	1985	Atalaya (ILC 200)	Med-tall, high yield
Syria	1982/86	Ghab 1 (ILC 482)	High yield, wide adaptation
	1986	Ghab 2 (ILC 3279)	Tall type, cold tolerant
Tunisia	1986	Chetaui (ILC 3279)	Tall type
	1986	Kassab (FLIP 83-46C)	Large seed, high yield
Turkey	1986	ILC 195	Tall, medium seed, cold tolerant

Potential of winter chickpea

Expected gain in the Mediterranean region

A conservative estimate is that the farmers may obtain a minimum of 500 kg/ha additional yield by adopting winter sowing.

The area of chickpea in the Mediterranean region during 1985-86 was 925,000 ha (Table 9). If the modest gain of 500 kg/ha is obtained by shifting from spring to winter sowing, the region as a whole may gain 462,500 tonnes additional production. If the selling price of chickpea is determined at US$ 1 per kg, as is the case in Syria, then the net gain in terms of dollar per annum comes to US$462 million.

Profit

Given yield results from farmers' managed trials at nine locations in the 1986/87 season and conservative prices, Dr. T. Nordblom, ICARDA Economist, estimated that these farmers increased their chickpea profits by more than 50 percent using the winter chickpea package (Table 10).

Practical problems in adoption of winter chickpeas

Often a question is raised that despite substantial gain in yield from winter chickpea by researchers why is the rate of adption slow by farmers? Some of the reasons are discussed here.

First, there is a need to publicize the advantages of winter chickpea through information media (radio, television, and newspapers). Planting large scale demonstration plots and organizing field days with the help of extension agents are other to inform farmers. Organizing in-country training courses on winter chickpea for extension workers would be beneficial.

Table 9. Area, yield and production of chickpea in the Meditarranean region during 1985-1986.

Country	Area (000ha)	Yield (kg/ha)	Production (000t)
Algeria	63	263	17
Cyprus	1	877	1
Egypt	10	1754	17
Greece	6	1184	7
Iraq	16	758	13
Iran	76	711	54
Italy	10	1213	12
Jordan	3	542	2
Lebanon	1	1184	1
Morocco	74	630	46
Portugal	25	515	13
Spain	89	641	57
Syria	59	679	39
Tunisia	42	726	30
Turkey	450	1102	1408
Total	925	875	809

Source: FAO Production Year Book.

Second, availability of seed is another bottleneck. All out effort should be made to increase and distribute good quality seeds. Farmers should be made aware of that their own seed for spring sowing is not good for winter sowing. Principles and techniques for seed production in chickpea have been described by Singh (1986).

Third, weeds can rob the advantage of winter sowing if not controlled. ICARDA has identified some chemicals (for example 2.5 kg a.i./ha. Igran plus 0.800 kg a.i./ha pronamide)) which provide effective control if sprayed between post sowing and pre-emergence. But availability of these herbicides in most countries is limited.

Fourth, if the winter chickpea is to be introduced in the dry area, seed inoculation with rhizobia will be required. This will need establishment of a inoculation production system.

Fifth, *Orobanche* is not much of a problem at present. But it needs to be monitored carefully because it is a serious problem for faba bean, pea and lentil. The work conducted at ICARDA indicates that chickpea is more tolerant to *Orobanche* than other winter-sown food legumes. Also highly resistant lines have been identified which could be used in breeding programme, if required.

Sixth, cultural operations, such as land preparation, planting and harvesting of chickpea may overlap with wheat and other crops which are traditionally winter-sown. This should not be a major constraint because hectareage under chickpea is around five percent of that of

Table 10. Chickpea production budget[a] in Syria, 1986/87.

	Spring chickpea	Winter chickpea	
	local	Ghab 1	Ghab 2
Yields			
Seed yield (kg ha^{-1})	991	1574	1629
Straw yield (kg ha^{-1})	650	1542	2127
Gross Crop Value[b]			
Seed sales (SYP ha^{-1})	10,901	17,314	17,919
Straw sales (SYP ha^{-1})	325	771	1,063
Total (SYP ha^{-1})	11,226	18,085	18,982
Costs (SYP ha^{-1})			
Tillage	410	310	310
Seed and seeding	1,800	1,800	1,800
Fertilizer	160	160	160
Weed control	-	1,000	1,000
Harvest operations	1,669	3,413	3,687
Total variable costs (SYP ha^{-1})	4,039	6,683	6,957
Sales - Costs = Profit (SYP ha^{-1})	7,187	11,402	12,025
Relative Profits (Spring = 1.00)	1,00	1,59	1,67

[a]/ *based on farmer-managed on-farm trials at 9 locations with large plots (>1 ha) of each type at each location.*
[b]/ Conservative market prices in 1987: SYP 11 kg^{-1} for seed, SYP 0.5 kg^{-1} for straw.
Source: Unpublished results from T. Nordblom and K.B. Singh.

wheat. Another associated problem often pointed out is that rain may cause delay in planting. This problem is common to all the winter-sown crops.

Seventh, some people ask that if there is a large scale adoption of winter chickpea and production goes up, then nations would be faced with a surplus. This is a theoretical question and if it happens chickpea can be fed to the cattle as is a practice in the Indian subcontinent.

Eighth, other socioeconomic implications are mentioned. But when you weigh the advantages of winter chickpea with the problems described here, then one would certainly opt for winter chickpea.

Seven reasons to grow winter chickpea

1. Increased yield per hectare. Winter-sown chickpea produces 50-100 percent more yield than spring sowing.

2. Increased protein per hectare. Winter-sown chickpea planted at Tel Hadya produced 406 kg/ha of protein vs. 239 kg/ha of protein for spring sown; while winter-sown chickpea planted at Terbol produced 521 kg/ha vs. 375 kg/ha for spring-sown (Table 11).

Table 11. Influence of planting-time on yield per hectare, protein content and seed size in kabuli chickpea.

	Tel Hadya		Terbol	
	Winter	Spring	Winter	Spring
Protein content (%)	20.0 ± 0.8	20.9 ± 1.0	19.6 ± 1.0	20.4 ± 1.2
100-seed wt. (g)	28.8 ± 3.4	27.5 ± 3.3	31.9 ± 3.6	30.4 ± 3.8
Yield (kg/ha)	2033 ± 344	1142 ± 230	2651 ± 356	1842 ± 209
Mean protein (kg/ha)	406	239	521	375

Source: Unpublished results from Singh, Williams and Nakkoul, ICARDA.

3. Increased nitrogen fixation per hectare. Nitrogen fixed by rhizobia is often between 80-90 kg/ha in winter-sown crop, whereas it is less than half for spring-sown crop.

4. Better utilization of available water. Owing to better water use efficiency, it is expected that cultivation of winter-sown chickpea will expand into drier areas.

5. Higher germination rate. On an average about 95 percent of seed will germinate with winter-sowning in comparison to about 75 percent germination for spring-sown.

6. Less fusarium wilt disease. This disease, which is a problem in parts of North Africa and South Europe, is less of a problem when chickpea is sown in winter because the crop matures early before the temperature is favourable for disease development.

7. Production can be mechanized. Winter-sown chickpea grows 40-60cm tall as compared to the height of 25-35 cm of a spring-sown crop and is thus better suited for machine harvesting. Besides machine harvesting, cereal drills have been modified to plant chickpea, and suitable herbicides have been identified which can be applied by machine to control weeds. Thus, all important operations of production can be fully mechanized.

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