# Agronomic studies on chickpea (Cicer arietinum L.)

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SUMMARY - The potential yield of chickpeas is high, particularly when sown early. Farmers have to be advised on proper crop management in order to enable them to attain high yields. With this aim in view experiments were carried out identifying optimun plant population and suitable weed control methods within a network of research in France. The optimun plant population is higher when date of planting is early, variety is compact and when enough water is available. Pre-sowing application of AVADEX is convenient. However, the best control is with pre-emergence application of such herbicides as BOCHAMP, CENT 7, PREMIUM, DINOGRANE SP, TRIBUNIL, ZEPHIR and neburon. Post-emergence herbicides are not so selective.

*RESUME - "Etudes agronomiques sur le pois chiche (*Cicer arietinum L.*)". Le potentiel de rendement du pois chiche est important notamment dans le cas de semis précoces. Aussi, les techniques de cultures conseillées aux agriculteurs doivent-elles viser à obtenir une production régulière et élevée. Dans le cadre d'un groupe de travail, des expérimentations ont été conduites sur deux des thèmes importants: (1) Déterminer le peuplement en fonction de la date de semis et du type variétal. Cet optimun est d'autant plus élevé que le semis est plus précoce, que la variété ramifie peu et que l'alimentation hydrique est bonne. (2) Eliminer les mauvaises herbes en précisant la sélectivité d'herbicides dont on connaît l'efficacité sur les mauvaises herbes. En pré-semis, on conseille AVADEX; en post-semis - pré-émergence qui constitue la meilleure période de désherbage, on peut utiliser BOCHAMP, CENT 7, neburon, PREMIUM, DINOGRANE SP, TRIBUNIL, ZEPHIR. Par contre, le désherbage en post-levée qui constitue une solution de rattrapage, demande quelques précautions.*

## Introduction

Several trials carried out in France (Wery, 1986) and other countries in the Mediterranean basin (Saxena, 1984; ICARDA, 1987) have shown that winter type chickpeas have a high potential yield (4-5 t/ha) particularly when sown early. However, to achieve this yield potential and to stabilize the yield, there is a need to adopt optimun crop management practices. Farmers are particularly very sensitive to stability in yield because it can seriously affect the economic profitability of the crop.

As with other seed legumes, the yield in chickpea depends on two factors: number of grains/m$^2$ at harvest time and the grain weight. Grain weight is difficult to predict because it varies greatly with climatic conditions (water deficit, temperature) during the transfer of assimilates to the grains. By contrast, farmers try to obtain the maximum number of grains/m$^2$, which depends on: the number of plants established/m$^2$, number of pods/plant and number of grains per pod. The number of plants established would depend on the quality of seed used as well as on the planting method. The number of pods/plant depend on the variety and the crop management including weed control and number of grains/pod mainly depend on the variety. Most of the kabuli type chickpea varieties only have one seed/pod (Wery, 1986).

In a network with several research organizations including l'Ecole Nationale Supérieure Agronomique de Montpellier (ENSA), la Fédération Nationale des Agriculteurs Multiplicateurs de Semences (FNAMS), l'Institut National de la Recherche Agronomique (INRA), l'Institut Technique des Céréales et des Fourragères (ITCF) and le Lycée Professionnel Agricole (LEPA) de Carmejane, experiments were carried out to define an optimum plant density for a given sowing date and type of variety and to indentify the best selective herbicides for chickpeas.

## Sowing density

Indeed optimal density may change with the sowing date and type of variety. Two trials were carried out in south-eastern France with 5 replications, comparing 3 densities (30, 60, 90 plants/$m^2$), 2 sowing dates (trial 1 - normal, 3 March and late, 2 April in spring; and trial 2 - in winter, 4 December and in spring, 5 March), and 2 varieties differing in spread and earliness (ILC 482, kabuli type, early, spreading; and ILC 3279, intermediate type, late compact).

Table 1 gives details of the trial and Tables 2 and 3 show results. Climatic conditions at the end of winter (trial 1) did not allow earlier sowing of the first date, because there was 80 mm of rain in February as against a normal of 49 mm. The weather thereafter was favourable because rainfall was regular (except in April which was very wet) and temperature was mild throughout the growing period.

With sowing at the beginning of March, yield of trial 1 was higher than that of trial 2 because of the number of pods/plant (Table 2 and 3).

Yield in trial 1 was better due to a higher number of grain/$m^2$ (about two times as much at density 1 and 3 for ILC 3279 and about 1.4 times as much for ILC 482). If the 1000 seed weight has a small variation in trial 1, this component explains an important part of the increase of yield in trial 2, in which the number of grains/$m^2$ was stable for the same variety and the same sowing date.

In each trial, the structure of plant was modified by sowing density. The number of pods/plant was higher with low density than with high density. Number of grains/pod did not change with treatments.

Dates of development stages were also modified by sowing time. For example, the beginning of flowering occurred about 10-15 days earlier with winter sowing than with spring sowing in trial 2. In the case of spring sowing (trial 1), chickpeas flowered 5-10 days earlier with March sowing compared with April sowing but flowering time was a little shorter (5-6 days) with April sowing. The harvesting date was very little modified with sowing in spring but it was about 8-10 days earlier with sowing in winter.

The results of two trials carried out in 1987 in the south-east of France, showed that the optimum plant population was about 60 to 70 plants/$m^2$ at harvest

**Table 1. Main characteristics of the two trials.**

| | Trial 1 | Trial 2 |
|---|---|---|
| Department | Alpes de Hte. Provence | Alpes de Hte. Provence |
| City | Digne | Gréoux |
| Soil type | Clayey silt | Clayey sandy silt |
| Rainfall | 341 mm (spring sowing) | 475 mm (winter sowing)<br>318 mm (spring sowing) |
| Previous crop | Winter barley | Winter wheat |
| Herbicides | Herbalt S | Tolion 303 |
| Fongicides | 0 | Blédor 3 (14/5) |
| Insecticides | 0 | Pirimor G (27/5) |
| Irrigation | 0 | 0 |

**Table 2. Effect of plant density on yield and yield components as affected by data of sowing and variety in trial 1.**

| Sowing date | Variety | Density pl/$m^2$ | Pods per plant | Grains /$m^2$ | 1000-seed weight (g) | Yield (q/ha) |
|---|---|---|---|---|---|---|
| 3/3/87 | ILC 482 | 41 | 48.4 | 1985 | 315 | 35.9 |
| | | 70 | 28.9 | 2080 | 330 | 43.7 |
| | | 102 | 25.1 | 2703 | 318 | 42.3 |
| | ILC 3279 | 33 | 40.0 | 1263 | 322 | 29.4 |
| | | 70 | 23.7 | 1679 | 321 | 37.7 |
| | | 93 | 23.5 | 2203 | 326 | 40.8 |
| LSD | Variety | NS | 1.0 | – | NS | NS |
| | Density | 1.0 | 5.0 | – | NS | 1.0 |
| | Interaction | NS | NS | – | NS | NS |
| 2/4/87 | ILC 482 | 30 | 35.3 | 1047 | 331 | 30.2 |
| | | 75 | 15.3 | 1172 | 335 | 36.0 |
| | | 108 | 13.3 | 1440 | 341 | 36.3 |
| | ILC 3279 | 20 | 39.4 | 741 | 355 | 24.3 |
| | | 57 | 20.2 | 1103 | 353 | 32.0 |
| | | 96 | 15.6 | 1409 | 331 | 33.6 |
| LSD | Variety | 1.0 | NS | – | 5.0 | 5.0 |
| | Density | 1.0 | 1.0 | – | NS | 1.0 |
| | Interaction | NS | NS | – | 1.0 | NS |

**Table 3. Effect of plant density on the yield and yield components as affected by date of sowing and variety.**

| Sowing date | Variety | Density pl/m² | Pods per plant | Grains /m² | 1000-grain weight (g) | Yield (q/ha) |
|---|---|---|---|---|---|---|
| 4/12/86 | ILC 482 | 35 | 23.8 | 863 | 332 | 27.7 |
| | | 59 | 13.8 | 801 | 346 | 32.5 |
| | | 99 | 9.1 | 922 | 363 | 33.0 |
| | ILC 3279 | 46 | 19.5 | 831 | 368 | 26.5 |
| | | 58 | 15.1 | 794 | 380 | 31.2 |
| | | 105 | 8.7 | 876 | 377 | 33.7 |
| | LSD | – | 4.0 | 89.5 | 16.5 | 2.6 |
| | CV (%) | – | 26.8 | 10.6 | 4.6 | 8.4 |
| 5/3/87 | ILC 482 | 42 | 14.5 | 622 | 304 | 23.9 |
| | | 72 | 9.0 | 597 | 317 | 26.4 |
| | | 112 | 5.2 | 535 | 318 | 28.1 |
| | ILC 3279 | 46 | 14.7 | 672 | 366 | 21.4 |
| | | 91 | 7.6 | 651 | 374 | 23.2 |
| | | 122 | 5.3 | 632 | 375 | 22.9 |
| | LSD | – | 1.5 | 56.1 | 9.2 | 1.3 |
| | CV (%) | – | 16.5 | 9.1 | 2.7 | 5.5 |

time.However, ILC 3279 could be grown with a slightly higher density because its spread was low. On average, the yield in ILC 3279 increased by 1.7 g/ha with increase in density from 70 and 100 plants/m² instead of 0.3 g/ha for ILC 482. Early sowing yields better than late sowing. Increasing the population does not help in counteracting the yield reduction due to the delay in sowing. Too high a population may even give excessive competition between plants resulting in a bigger sensitivity to climatic conditions and finally a decrease in yield. These results confirm those obtained with a desi type, INRA 199 variety (Leger Cresson, 1984). Optimum population was about 40 to 50 plants/m² with spring sowing, and about 80 plants/m² with winter sowing. The same trends were obtained in Syria (Saxena, 1984) but with a lower population. These results do not change the general recommendation on plant density for spring sowing in the south of the Mediterranean basin which is 30 or 40 plants/m².

Soil-climate effect is difficult to measure with only two trials. This is why this study has to be continued in future. It appears (Fig. 1) that the productivity is clearly higher in trial 1 than in trial 2. This however does not change the conclusion on optimum density. Nevertheless, it would seem that the optimum density may be higher as the growth conditions become more favourable: deep and fertile soil, enough water available.

## Herbicides

Elimination of competition due to weeds is important for high chickpea productivity. Experiments were, therefore, conducted at several sites in France since 1986 to determine the efficacy of herbicides against weeds and to identify a selective herbicide for chickpea crop.

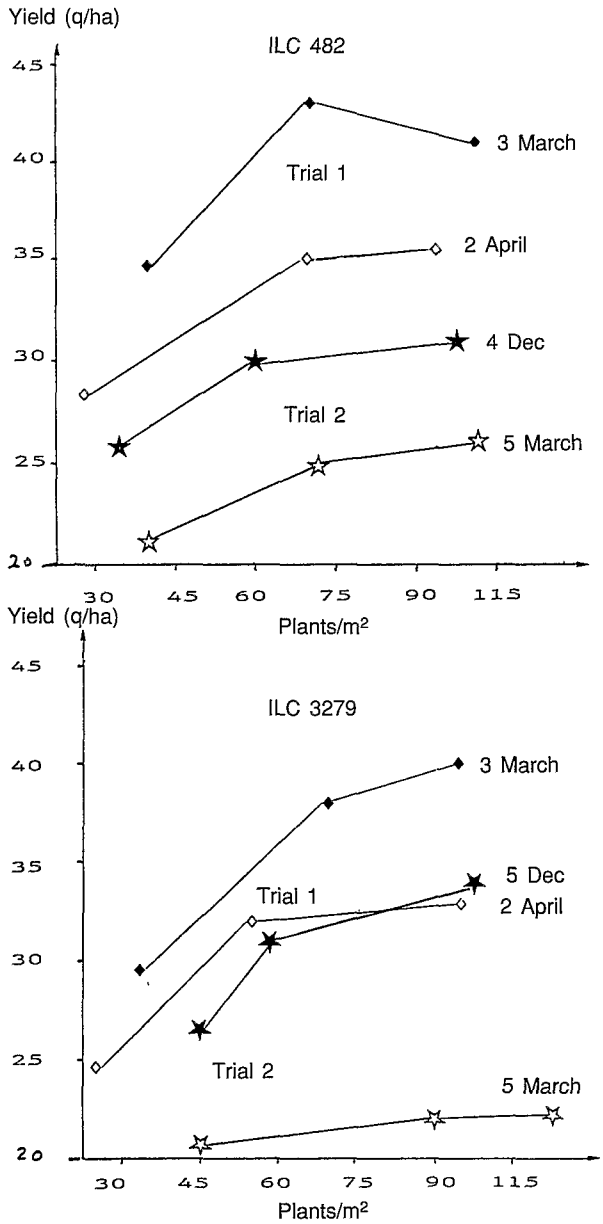


Fig. 1. Effect of density and sowing time on grain yield of two chickpea varieties at the two sites.

Selectivity study with herbicides well known for their efficacy on weeds was carried out with bands of several crops, including chickpeas. Herbicides were sprayed perpendicularly as pre-sowing, post-sowing - pre-emergence, and post-emergence; at two rates of application (1 N and 2 N). Checks without herbicides were left after every two plots, to test the efficacy of herbicides and their selectivity. Visual ratings were used: 0 (no effect and no visual symptoms) to 10 (destroyed crop).

Table 4 shows trial characteristics, Table 5 selectivity of herbicides and Table 6 efficacy of herbicides useful but non homologated for chickpeas. The results can be summarized below:

Pre-sowing herbicides: low temperatures during the winter of 1985-1986 affected the efficacy of herbicides sprayed on Cadarache trial: AVADEX, antigrass (particularly against *Avena fatua*) and anti broad-leaved had a very good selectivity; similar was the case with CAPSOLANE and RACER. On the contrary, BONALAN had bad selectivity.

Post-sowing - pre-emergence herbicides: antigrass herbicides Neburon, BOCHAMP, PREMIUM and anti broad-leaved CENT 7 had a good selectivity at normal and double dose. WINNER in 1988 confirmed a good selectivity. HERBALT and TOLION 303 were also good but they are recently off the market. DINOGRANE, TRIBUNIL and ZEPHIR were selective but with double dose, i.e. if there is a double passage of sprayer in field conditions, there is a risk of phytotoxicity.

Other products tested were toxic, i.e. FOXTO and also MEGAPLUS which is less toxic for chickpeas than for peas. The usefulness of some products i.e. ACORIT, BUTISAN, CHALLENGE, CHANDOR, ESCURAN, FERMAX has yet to be confirmed.

Post emergence herbicides: Dinosebe acetate (ARETIT) recently off the market, damaged the crop a little but if climatic conditions are good, there is no toxic effect on the yield.

Some herbicides are unusable on chickpeas, i.e. BASAGRAN which is good for peas, is phytotoxic on chickpea at the normal dose; BLAZER 25, GOLTIX and TROPOTONE are not selective enough during some days after spraying. However, these products must be tested again.

In conclusion it can be said that there are very few herbicides useful on the chickpea crop at this time. In pre-sowing AVADEX BW may be advised. For post-sowing - pre-emergence time recommendation on herbicides is same as for peas and is best for security and efficiency. Nevertheless, withdrawal of nitrofene (HERBALT S, TOLION 303) reduces the choice to products such as BOCHAMP, CENT 7, neburon, PREMIUM, DINOGRANE SP, TRIBUNIL and ZEPHIR. These herbicides generally are not efficient enough against weeds. Post emergence weed control is needed to correct bad efficien-

**Table 4. Main characteristics of experimentation.**

| | 1986 | | 1987 | | |
|---|---|---|---|---|---|
| Department | Bouches du Rhô ne | Cher | Bouche du Rhô ne | Aude | Hérault |
| City | Cadarache | Levet | Cadarache | Loudes | Montpellier |
| Soil type | Clayey silt | Silty | Clayey silt | Clayey chalky | Clayey silt |
| Previous crop | Fallow land | – | Wheat | Castor oil plant | Wheat |
| Sowing date | 26/11/85 | 02/05/86 | 05/03/87 | 06/03/87 | 20/11/86 |
| Variety | INRA 199 (desi) | – | INRA 199 (desi) | Population (kabuli) | ILC 3279 |
| Treatments : | | | | | |
| Pre-sowing date | 26/11/85 | 02/05/86 | 12/03/87 | 18/03/87 | – |
| Pre-emergence date | 27/11/85 | 09/05/86 | 12/03/87 | | 20/11/86 |
| Post-emergence date | 10/04/86 | 23/05/86 | 16/04/87 | 06/04/87 | 06/03/87 |
| Stage of chickpeas | 6 leaves | 2-3 leaves | 4 leaves | 2-3 leaves | 6 leaves |
| Observations: | | | | | |
| 1 date | 03/04/86 | | 24/04/87 | – | – |
| Stage of chickpeas | 6 leaves | | 8 leaves | – | – |
| 2 date | 30/05/86 | 30/05/86 | 02/06/87 | 20/05/87 | 05/05/87 |
| Stage of chickpeas | First flat pods | | Full flowering | Beginning of flowering | Beginning of flowering |

**Table 5. Selectivity of herbicides on chickpeas.**

| Trade name | Active matter | Dose in | | Sélectivity at different locations | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cadarache | | | | Levet | | Cadarache | | | | Loudes | | Montpellier | |
| | | l or kg/ha | | 3/4/86 | | 30/5/86 | | 30/5/86 | | 24/4/87 | | 2/6/87 | | 20/5/87 | | 05/05/87 | |
| | | N | 2N | N | 2N | N | 2N | N | 2N | N | 2N | N | 2N | N | 2N | N | 2N |
| *PRE-SOWING* | | | | | | | | | | | | | | | | | |
| AVADEX BW | triallate (400 g/l) | 3,5 | 7 | 2 | 0 | 0 | 0 | – | – | | | | | | | | |
| CAPSOLANE | EPTC (360 g/l) | 8 | 16 | | | | | 0 | 2 | | | | | | | | |
| RACER | flurochloridone (250 g/l) | 2 | 4 | | | | | 0 | 1 | | | | | | | | |
| BONALAN | benfluraline (180 g/l) | 6 | 12 | 3 | 5 | 3 | 5 | 1 | 5 | | | | | | | | |
| *POST SOWING PRE-EMERGENCE* | | | | | | | | | | | | | | | | | |
| BOCHAMP | trifluraline (125 g/l) + néburon (125 g/l) + linuron (60 g/l) | 6 | 12 | | | | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 2 | 5 |
| CENT 7 | isoxaben (125 g/l) | 0.5 | 1 | | | | | | | 0 | 2 | 0 | 2 | 0 | 1 | 2 | 3 |
| Néburon PREMIUM | néburon (60 %) terbutrine (200 g/l) + néburon (300 g/l) | 4 | 8 | 0 | 2 | 0 | 1 | | | | | | | | | | |
| | | 5 | 10 | 0 | 2 | 0 | 0 | 0 | 2 | | | | | | | 1 | 2 |
| DINOGRANE SP | chlométoxyfène (25 %) + néburon (24,7 %) | 8 | 16 | | | | | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 3 |
| TRIBUNIL | methabenzthiazuron (70 %) | 4 | 8 | 0 | 0 | 0 | 3 | | | 0 | 2 | 0 | 2 | 0 | 1 | 2 | 2 |
| ZEPHIR | terbutryne (500 g/l) | 4 | 8 | 0 | 3 | 0 | 4 | | | | | | | | | | |
| FOXTO | bifenox (133 g/l) + néburon (200 g/l) + isoproturon (133 g/l) | 4 | 8 | | | | | 3 | 8 | | | | | | | | |
| MEGAPLUS | pendimenthaline (200 g/l) + imazamethabez (125 g/l) | 5 | 10 | | | | | | | 2 | 4 | 4 | 6 | 2 | 5 | 1 | 3 |
| *POST-EMERGENCE* | | | | | | | | | | | | | | | | | |
| DINOSEBE acétate | Dinosébe acétate (523 g/l) | 3 | 6 | 2 | 4 | 1 | 3 | 1 | 4 | 2 | 3 | 0 | 2 | 4 | 7 | 0 | 4 |
| BASAGRAN | bentazone (480 g/l) | 2.5 | 5 | 9 | 9 | 8 | 9 | 7 | 9 | 8 | 9 | 5 | 7 | 4 | 7 | 0 | 2 |
| BLAZER 25 | acifluorfène | 1 | 2 | | | | | 4 | 6 | | | | | | | | |
| GOLTIX | metamitrone (70 %) | 4 | 8 | | | | | 3 | 4 | | | | | | | | |
| TROPOTONE | MCPB (400 g/l) | 4 | 8 | 7 | 7 | 1 | 3 | 4 | 7 | | | | | | | | |

**Table 6. Efficacy against weeds of herbicides usable on chickpeas (note: these herbicides are not authorised for chickpeas, their use is the responsibility of users).**

| Trade names | Firms | Grass | | | | | Broad-leaved | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Avena fatua* | *Lolium* | *Poa* | *Alopecurus* | *Agrostis* | *Matricaria* | *Veronica* | *Galium* | *Polygonum* | *Chenopodium* |
| *Pre-sowing* | | | | | | | | | | | |
| AVADEX | MONSANTO | ○ | ○ | ● | ○ | ● | ▲ | ▲ | ▲ | ▲ | ▲ |
| *Post-sowing - pre-emergence* | | | | | | | | | | | |
| BOCHAMP | R.S.R. | ▲ | ○ | ● | ○ | ● | ● | ● | ▲ | ○ | ● |
| CENT 7 | ELANCO | – | – | – | – | – | ● | ● | ▲ | | |
| Néburon | Several | ▲ | ▲ | | ○ | | ◐ | ▲ | ▲ | ○ | ◐ |
| PREMIUM | PEPRO | ▲ | ▲ | ● | ○ | ● | ● | ▲ | ▲ | ○ | ● |
| DINOGRANE SP | SOPRA | ▲ | ● | ● | ○ | ● | ● | ● | ▲ | ● | ● |
| TRIBUNIL | BAYER | ▲ | ▲ | ● | ○ | ● | ● | ▲ | ▲ | ○ | ● |
| ZEPHIR | CIBA-GEIGY | ▲ | ○ | ● | ○ | ● | ○ | ○ | ▲ | ○ | ● |
| *Post emergence* | | | | | | | | | | | |
| Dinosèbe acétate | Several | ▲ | ▲ | | ▲ | | ◑ | ◑ | ◑ | ◑ | ◑ |

● Satisfactory efficacy
◐ Medium efficacy in spring, good in winter
◑ Medium efficacy in winter, good in spring
○ Medium efficacy, satisfactory in some conditions
▲ Insufficient efficacy

cy at sowing time. Dino seb or MCPB active materials must be sprayed with certain precautions, i.e. a precise dose and spray at the end of the day with temperature less than 20°C. BASAGRAN should be excluded.

## Conclusions

Research of optimum population must be continued and probably increased to advise farmers in regard to the following conditions: sowing time, variety, fertility of soil, climate. Since sowing is an important step in the crop husbandry and seeds are expensive, farmers need to reduce planting costs. It is probably that studies are not necessary on testing seed-drills because available results of experiments with peas can be applied to chickpeas.

Research on selectivity of herbicides must be continued to test new active materials. More experiments on winter chickpeas should be carried out in the future.

It would be better to have varieties sown in autumn with good resistance to the cold; this is probably the best way to increase and stabilize yield by reducing risks of climate.

Finally, to have a better knowledge of this species and of adaptation in different regions, it seems necessary to determine the temperature requirement for different growth stages and discover the reactions of plants towards cold and hot conditions. This information, concerning temperature effects on yield components (number of plants/m$^2$, number of pods/plant, number of grains/pod and TSW), will help interpretation of results of experiments and establishing a diagnostic method for chickpea similar to the one used on pea crops.

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