

Crop Profile for Chickpeas

I - Generalities

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*Crop – Chickpeas (including Desi and Kabuli) *Cicer arietinum* L*

Regions – Brown and Dark Brown soil zones of Saskatchewan, with a very small acreage in Alberta

Short history and use®

Chickpea (*Cicer arietinum* L.) is the third most important food legume grown in the world. Worldwide, approximately 11 m ha with 9 million ton production are grown. It is grown in over 45 countries in all continents of the world. The crop provides a high quality protein to the people in developing countries. In the developed countries, consumers consider it as a health food. (1)

Chickpea (*Cicer arietinum* L.) is an ancient pulse crop first grown in Turkey about 7,000 B.C. It was traditionally grown in semi-arid zones of India and Middle Eastern countries. A member of the family Leguminosae, chickpea can fix nitrogen from the atmosphere. The growth habit is erect, with most of the pods formed in the top part of the plant.

Growers in Saskatchewan began commercially producing chickpeas in the mid-1990's with a relatively small acreage and the acreage has grown substantially over the ensuing eight years. (2)

II – General commodity information

A – Production

Canada produces two different classes of chickpea: Kabuli and Desi. Currently, production area is split evenly with 50% being Kabuli, and the other 50% being Desi. Kabuli chickpeas yield less, and produce on average 1,300 kg/ha while Desi will produce around 1,550 kg/ha. (2)

Kabuli chickpea is best adapted to the Brown soil zone, while Desi chickpea is best adapted to the Brown and Dark Brown soil zones of Saskatchewan. Chickpea is not well adapted to saline soils, soils with high clay content, soils that are slow to warm up in the spring, or to high moisture areas since it will not tolerate waterlogged soil. (2,3)

Around 96% of the Canadian chickpea production is centered in these two soils zones in Saskatchewan, with the other 4% in Alberta. (2)

Table 1 gives acreage figures by year for chickpeas. Of note is the explosive growth in the acreage of the crop. In less than 10 years, the crop has gone from zero production to almost a half a million hectares. This logarithmic growth has led to acute pest management problems. The rapid increase in the crop has led to enhanced disease problems. The infrastructure of tools and

information needed to manage these problems has simply not been able to keep up with the research and extension issues that centre on such a rapid expansion in acres.

Table 1 - Canadian Chickpea Production

Year	Average Yield t/ha	Area (ha)	Production (t)	Cash Value (CDN)*	Yearly Production Costs (CDN)**
1991-1992	-	-	-	-	-
1992-1993	-	-	-	-	-
1993-1994	0.58	480	279	\$ 114,390	\$ 216,000
1994-1995	0.63	960	603	\$ 247,230	\$ 432,000
1995-1996	1.01	1,000	1,012	\$ 414,920	\$ 450,000
1996-1997	1.33	3,000	3,984	\$ 1,633,440	\$ 1,350,000
1997-1998	1.36	11,000	15,000	\$ 6,150,000	\$ 4,950,000
1998-1999	1.34	38,000	51,000	\$ 20,910,000	\$ 17,100,000
1999-2000	1.42	139,000	197,000	\$ 80,770,000	\$ 62,550,000
2000-2001	1.37	283,000	387,000	\$ 158,670,000	\$ 127,350,000
2001-2002	1.04	480,000	500,000	\$ 205,000,000	\$ 216,000,000

* Based on 6 year average price of \$410/tonne

** Average total cost of \$450/ha (includes inputs, equipment, interest, crop insurance, etc)

Source – Pulse Canada 2003 data

B – Quality

The Canadian Grain Commission does chickpea grading. Grading factors are the amount of immature green seeds, Botrytis or Sclerotinia in the seed, admixtures, small seed size and the lack of seed uniformity. See Appendix A for the actual grading criteria. (3)

C- Market Diversity

There are two commercial classes of chickpea: Desi and Kabuli. The Desi type has a thick, coloured seed coat with coloured flowers, and is either dehulled and split ('chana dal') or dehulled and ground into flour ('besan'). The Kabuli type (also known as garbanzo bean) has a thin, white seed coat with white flowers, and is used mainly in salad bars, vegetable mixes, or ground into humus. (2, 6)

D – Market Status

Note that exports by region figures are not available. Source – Pulse Canada 2003

Table 2 - Canadian Chickpea Market Information

Crop Year	Thousand Metric Tonnes					
	Production	Imports	Total Supply	Exports	Total Domestic Use	Ending Stocks
1996-1997	N/A	N/A	N/A	N/A	N/A	N/A
1997-1998	15	3	18	3	14	1
1998-1999	53	2	56	14	37	5
1999-2000	197	5	207	56	136	15
2000-2001	388	5	408	179	199	30
2001-2002*	447	12	489	190	179	120
2002-2003*	150	10	280	170	100	10

* forecast

In recent years, world production of chickpea has ranged from 6.65 million MT up to 8.94 million MT. India produces a significant amount of the chickpeas, but consumes all of that locally. India usually accounts for around 70% of production, with Pakistan, Turkey, Canada, Mexico, Iran, and Australia accounting for an additional 23%. As the following export chart (Figure 1) shows, over the past few years there has been a downward trend in production in Australia and Turkey, mostly due to drought or increasing disease pressure. (5)

Countries in the Indian sub-continent and Australia produce mainly the Desi type, Canada produces both the Kabuli and Desi types, and the remaining countries produce mainly the Kabuli type. (2) World production consists of about 85% Desi type and 15% Kabuli type (1)

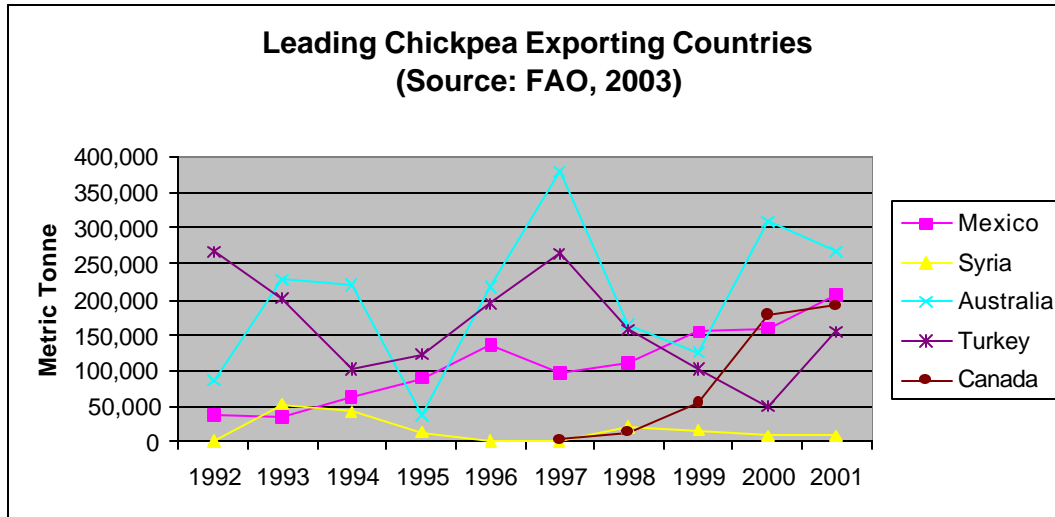


Figure 1. Exporting nations –chickpeas. Source FAO website.

Figure 2 shows the major chickpea importing countries. Other smaller importers of chickpea include Iran, Italy, Libya, Lebanon, and the US. Spain, Italy, and the US demand premium quality Kabuli chickpea, while India, Bangladesh and Pakistan demand both Kabuli and Desi types. Due to its close proximity, Australia has a marketing advantage over Canada in the Indian subcontinent. However, a significant opportunity exists for Canada in the American, European and Mediterranean chickpea markets. (1)

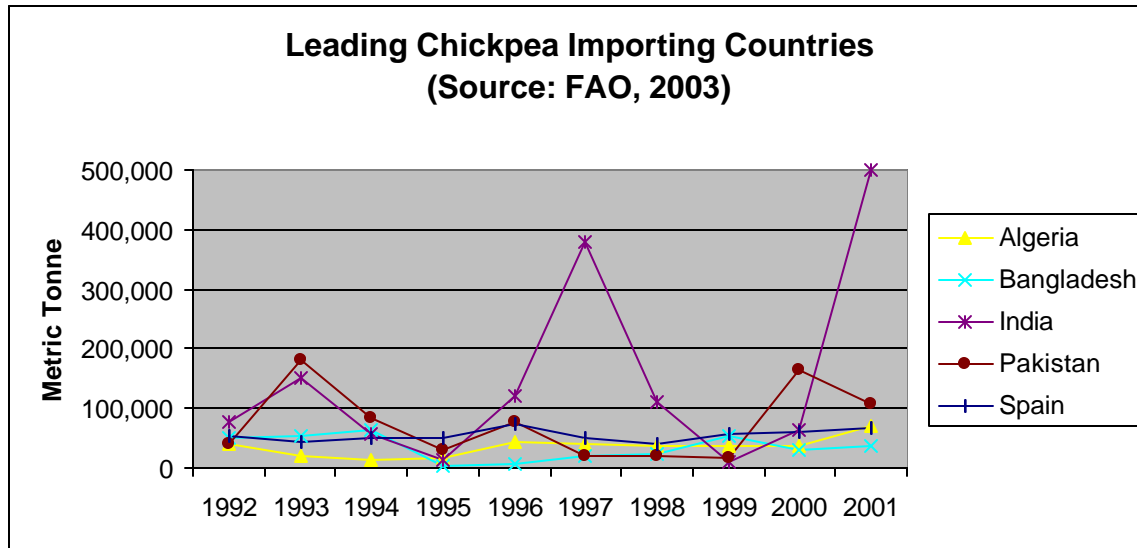


Figure 2. Importing nations – chickpeas. Source FAO website.

III – Non-Pest Oriented Cultural Practices

A – Crop Rotation Practices

The recommended crop rotation for chickpea is once every four years, mostly because of the aggressive nature of ascochyta blight, one of the major diseases in chickpea. A once in four-year rotation will allow for the breakdown of chickpea residue on which the disease thrives. Planting chickpea adjacent to a previous years crop should also be avoided. A different crop, such as a cereal, should be planted as a border strip adjacent to the chickpea stubble to avoid crop loss and the rapid spread of ascochyta. The majority of producers will follow this rotation, usually having chickpea following a cereal.(2,7)

Chickpea production is often successful in rotation with cereal grains such as durum wheat. Chickpea does not leave a lot of crop residue, so cereal crops with tall stubble grown before and after chickpea provide much-needed residue to protect the soil from erosion.(2)

Chickpea is susceptible to the soil residue from various herbicides used in previous years, so it is important to keep good records and take this into account when choosing a rotation (for more information about herbicide residue issues, see section D – 1 Summary).

B – Varieties, Cultivars and Rootstocks

Most chickpea varieties have leaves with 9 to 15 leaflets. These varieties are described as having a fern-leaf structure. Some Kabuli varieties, such as CDC Xena, CDC Diva, Sanford and Dwelley, have a single (unifoliate) leaf structure instead of leaflets. (2,3)

Chickpea has an indeterminate growth habit, meaning flowering and pod filling will continue simultaneously or alternately as long as temperature and moisture permits growth to occur. Since no chemical desiccants are registered for use on chickpeas, a moisture or nitrogen stress is required to encourage seed set and maturity. (2,3)

Two other major limitations for chickpea production in Canada are the long growing season required for current varieties, as well as the aggressive nature of the disease ascochyta blight. There are currently no varieties with good resistance to ascochyta blight. To date, fern-leaf varieties tend to be less susceptible than unifoliate-leaf varieties, and do not develop symptoms until later in the season. Breeding research for new chickpea varieties focuses mainly on addressing these two issues.(2,3)

Currently, the main Kabuli chickpea varieties are Sanford and Dwelley for large seeded varieties, and Amit (originally named B-90) for small seeded varieties. The main Desi variety grown is Myles. The Sanford, Dwelley and Myles varieties are U.S. varieties, while the Amit is a European variety. Most of the seed for these varieties has come from outside Canada, since chickpea production is so new, and there were limited seed growers here in Canada. These varieties are beginning to be replaced by new, Canadian bred varieties mostly from the Crop Development Centre (CDC) out of Saskatoon, Saskatchewan. The certified seed for these varieties is being grown in Saskatchewan. In general, farmers will use certified seed only 1 out of every 3-4 years (approx. 30% of acres seeded with certified seed). (2,3)

C – Crop Establishment

Seed quality is a very important factor for a successful chickpea crop. Seed should be tested for germination, disease levels and purity. Since ascochyta is such a major disease in chickpea and can be seed-borne, seed having no ascochyta should be used. If there is some seed-borne ascochyta present, a fungicide seed treatment such as Crown (carbathiin, thiabendazole) should be used. (2,3)

Chickpea must be handled carefully, since the growing point for the seed is exposed. Typically the seed is beaked and wrinkled or ribbed. The beak is the protruding seedling root tip. Kabuli and Desi chickpea are handled in a slightly different way at seeding, due to their different seed coats. Kabuli chickpea have a very thin, cream-colored seed coat. The use of a fungicide seed treatment such as Apron FL (metalaxyl) is recommended to protect the seed from soil borne diseases. Desi chickpea, on the other hand, has a thick, dark-colored seed coat and does not usually require a seed treatment before planting. (2,3,7)

Chickpea, like many legumes, has the ability to fix 60-80 per cent of its nitrogen requirement from the atmosphere under ideal conditions. For this to occur, the chickpea strain of nitrogen-fixing inoculant (*Rhizobium*) is required. It is essential that an inoculant specifically developed for chickpea is used. Care should also be taken when using treated seed. The fungicide seed treatment should be allowed to dry before inoculant is applied. It is also recommended to use a granular inoculant, since the granule is separated from the seed. (2,3)

Chickpea should be seeded at depths of 3½ to 6 cm, preferably into moist soil to provide proper germination and assure inoculant survival. Seeding rates will vary based on seed size and percent germination, but typically Kabuli chickpea is seeded at 145 kg/ha and Desi chickpea is seeded at 100 kg/ha. The minimum average soil temperature for Kabuli should be 10°C, while Desi could be seeded a little earlier at 7°C (due to Kabuli's increased risk of soil borne diseases). Seeding of chickpea in Saskatchewan is usually performed around late April/early May. It should be noted that the newly emerged seedlings are frost tolerant, so spring frost is not an issue when seeding.(2,3)

Typically, other legume crops grown in Saskatchewan need to be rolled after seeding to make a more uniform seedbed, and facilitate easier harvest in the fall. Land rollers are less beneficial in chickpea than in pea and lentil since the plants do not lodge and the stubble height is greater.(2,3,7)

D – Specialized Production Systems

There are no specialized production systems for chickpea.

E – Crop Cycle / Growth Stages

Chickpea is heat tolerant and relatively drought tolerant due to its long tap root, which allows it to use water from greater depths than other pulse crops. Chickpea is a poor competitor with weeds, and will usually require an in-crop chemical herbicide application. Since disease is also a major issue for chickpea, at least one, if not multiple, in-crop fungicide applications may also be made.(2,7)

F – Utilization of Plant Growth Regulators

There are no plant growth regulators used in chickpea production.

G – Harvest Practices

No Desiccants or pre-harvest weed control treatments are registered for use on chickpea in Canada, and should not be used to avoid the risk of having the crop impounded or the risk of having the crop become non-saleable. Because of the crops indeterminate growth habit, a moisture or nitrogen stress is required to encourage seed set and maturity.

Chickpea plants have stiff stems and a relatively upright growth habit, with pods developing several inches above ground. Intact pod loss can occur as a result of breakage of the small stem that attaches the pod to the plant, but pod shattering is not as common as in some other legumes (although with poor growing conditions, this can increase).(2,3)

Chickpea is usually straight-cut (meaning one-pass with the same implement will cut the stems off the plants, and harvest the seed from the pods), but can be swathed ahead of the combine if straight-cut equipment is not available. Swathing should be done when the plants are slightly damp in order to reduce intact pod loss. Wind is also a factor, since it can damage swaths. Since green, immature seeds can downgrade your chickpea and decrease its value, it is important for producers to harvest when the majority of the crop is mature. This may require the field to be harvested in stages, leaving immature areas to a later date.(2)

Producers normally combine when the seeds are at approximately 18% moisture. Care must be taken not to damage the seed, especially the large Kabuli types. Safe storage is at 14 per cent moisture or less.(2)

Early fall frost can also result in green immature seed in the harvested crop, and is common in regions outside the areas of best adaptation for the crop. This will significantly reduce the grade and value of the crop. (2)

H – Post-harvest Practices

A significant amount of the crop is stored on farm, for at least a short while, before it is delivered to the processor. Chickpea needs to be stored in a hopper bottom bin, preferably with aeration (fan system to circulate air throughout the bin). When chickpea is harvested, the outside seed coats moisture level doesn't always reflect the overall moisture level of the inside core. After a few days the moisture level of the seed will even out, and the crop may then require aeration, since the seeds need to be stored at maximum 14% moisture. The more serious pulse producers will use a conveyor to get the chickpea into the bin, versus the typical grain auger, since this will minimize the risk of damaging the seed. (2)

I – Workers Activities and Availability During the Season

Chickpea does not require additional workers during the season.

J – Pruning and Nutrient Management

Fertility requirements for chickpea are not well defined. Based on limited data, the requirements for phosphorus, potassium and sulphur are similar to pea or lentil. A well-inoculated crop should not require nitrogen. To date, no research has been done in Saskatchewan regarding micronutrient requirements for chickpea. (2)

Chickpea seed is very sensitive to seed fertilizer. Nitrogen fertilizer should not be placed with the seed. Some phosphorous can be placed with the seed, with any additional product side-banded away from the seed. For potassium and sulphur, it should be banded or broadcast. (2)

IV – Production Problems

A – Introduction

Many of the production problems associated with chickpea production centre around the fact that the crop has increased in acres so quickly that there has not been sufficient time to develop crop protection tools and techniques in keeping with the pest issues that are arising with the crop. In the past two years, disease has stricken the crop throughout more moist areas of Saskatchewan.

B – Non-pest Problems

i) Summary

A complete list of priority needs is given under *Section V – Critical Needs*. The main non-pest problem for chickpea production in Saskatchewan is the late maturity of the crop, combined with the indeterminate nature of the plant. This puts chickpea at an increased risk for fall frost damage. Some other, less concerning non-pest production concerns are safe handling and storage of the crop, as well as its depletion of the subsoil moisture levels in the field. (2)

ii) Key Factors (2,7)

- Maturity – Chickpea is a long-season crop, while Saskatchewan typically has a short growing season. Under ideal conditions, it's growing season is long enough for some of the new varieties being introduced, but anything that sets the crop back can jeopardize the quality of the crop (late seeding, slow germination, disease, hail/wind damage, etc).
- Another concern is that chickpea has an indeterminate growth habit, meaning flowering and pod filling will continue simultaneously or alternately as long as temperature and moisture permits growth to occur. Since no chemical desiccants are registered for use on chickpeas, a moisture or nitrogen stress is required to encourage seed set and maturity. If the chickpea plants are immature when the first hard, killing frosts come in the fall, it can increase the amount of green, immature seeds in the sample, which will decrease the quality and price of the crop.
- Fall Frost – As mentioned in the above maturity description, a hard killing frost in the fall on an immature chickpea crop will increase the amount of green seeds, thus decreasing the quality and price of the crop.
- Storage – Producers must keep an eye on the moisture level of their chickpea crop, especially shortly after harvest. When a chickpea seed is harvested, the outside seed coat normally has a lower moisture level than the inside of the seed. As the chickpea sits in the bin, the moisture level evens out (sometimes referred to as the seeds temper or sweat) and the overall moisture level can rise. So a crop that was harvested at a safe moisture level could have a moisture level higher than 14% a week later (the maximum moisture level to

safely store the crop). If this is left untreated, the crop could heat and start to spoil. This is the main reason to put chickpea in a hopper-bottomed bin that has aeration, which when left on can bring down the moisture level of the chickpea.(7)

- Handling – Care needs to be taken when handling chickpea seed in order not to damage the beak, or crack the seed coat, which can both downgrade the quality of the sample. This is especially important under extreme cold conditions, such as hauling chickpea to the processor in the winter. The cold can cause the seed coat to become quite fragile, and crack easily when handled.

- Soil Moisture Depletion – Chickpea has a deep tap-root, which allows it to use water from greater depths than other pulse crops. But because of its indeterminate nature, and the fact that it continues growing into the fall, it can deplete the subsoil moisture in the field. If it is a dry fall, with limited winter precipitation, this can negatively affect the yields of the cereal crop the following year. This makes chickpea less attractive than other pulse crops, which have shallower root systems.

C – Plant Pathogens/Diseases

i. Summary

A complete summary of critical disease needs is given in *Section V. Critical Needs*. Disease problems are the biggest production problems chickpea growers face in Canada. Some problems are seed-borne (such as ascochyta blight, botrytis grey mould, and sclerotinia stem rot), and can be minimized by the use of a proper seed treatment, and by using disease free seed. Other problems are common soil-borne diseases (root rot) with multiple host crops, which again can be minimized by the proper use of a seed treatment. But once a crop has the disease, there is no fungicide treatment that can limit the damage of that disease (although some diseases can be prevented by at least one, if not multiple, in-crop fungicide treatments).

ii. Key Factors by Pathogen (2,3,7,8)

- Ascochyta Blight (*Ascochyta rabiei*)
 - Host Crops – Chickpea
 - Biology – Ascochyta blight is a devastating seed and residue-borne fungus. Lesions develop on the stem, leaves of pods. Within the lesion, pycnidia are formed, in which spores are produced. Under moist conditions, the spores will ooze out of these structures and spread by rain-splash to surrounding plants. It takes at least 24 hours and rainfall or humid conditions for the spores to germinate and penetrate the plant. Optimum temperatures for infections are between 20-25 C. New lesions begin as tiny spots, but will continue to expand under moist conditions. Under ideal conditions, the disease can have multiple infection cycles within one season. The pathogen can survive for several years on exposed crop residue.
 - Percent Hectares Affected – 90%

- o Percent Hectares Treated – 98% of seed is treated with a fungicide like Crown (carbathiin and thiabendazole); virtually all the Kabuli crop is sprayed with an in-crop fungicide (around 25% sprayed twice) and 50% of the Desi crop is sprayed with an in-crop fungicide
- o Potential Crop Damage – Can cause losses of up to 90% of yield in Kabuli, and approximately 50% of yield in Desi if not treated.
- Botrytis Grey Mould (*Botrytis cinerea*)
 - o Host Crops – Chickpea
 - o Biology – Grey mould survives in the seed, on crop residues and in the soil. Chickpea plants may be infected at any stage of growth. Infected seed is often the primary cause of infection. Infected plants produce masses of spores, which may become air-borne and spread the disease rapidly. Once the disease is established, conditions under the crop canopy are ideal for infection and spread of the disease. Botrytis grey mould is a very opportunistic disease, so poor weather conditions at flowering/podding/harvest, any physical injury to the crop (herbicide damage, wind damage, hail), or a significant amount of pod abortion (increasing the amount of crop residue on the ground) will all increase the disease pressure in a field.
 - o Percent Hectares Affected – 10-20% (worse in some years)
 - o Percent Hectares Treated – 98% of seed is treated with a fungicide such as Crown (carbathiin and thiabendazole)
 - o Potential Crop Damage – Can lose 10-20% of yield, as well as decreased quality due to seed discoloration.
- Root Rot (*Fusarium solani*, *Rhizoctonia solani*, and *Pythium*)
 - o Host Crops – Chickpea, dry bean, sunflower, soybean, lentil, pea, canola, clover, flax
 - o Biology – The fungi causing root rot are soil borne. Root rotting fungi can attack any part of the root system and even the lower portion of the stem at the soil line. When young seedlings are infected with root rot, they usually die. Infected plants may appear yellowed and stunted.
 - o Percent of Hectares Affected – 90%
 - o Percent Hectares Treated – 98% of Kabuli seed and around 50% of Desi seed is treated with a fungicide like Apron FL (metalaxyl)
 - o Potential Crop Damage – Can lose up to 90% of your Kabuli seedlings to *Pythium* if not treated, 20-30% of Desi seedlings lost if infected.
- Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)
 - o Host Crops - Dry beans, field peas, canola, sunflowers, chickpeas, lentils, mustard, and potatoes
 - o Biology - The fungus overwinters as hard black bodies or sclerotia in crop debris and in the soil. The disease cycle begins with the germination of the sclerotia to produce small, mushroom-like structures. Warm (15-25° C), wet weather one to two weeks before flowering, coupled with a thick bean canopy favor this disease. Once these ‘mushrooms’ have matured, each of them can release up to 2 million spores over a 5-10 day period. These spores germinate and infect bean plants, aided by a dead food source (usually the bean blossoms or pedals). The disease develops most rapidly at temperatures of 20-25° C. The fungus can spread from the dead blossoms to adjacent flowers, stems, leaves, and pods within 2-3 days. The sclerotia formed may persist in the harvested pods and seed, fall to the soil, or remain in the crop residue.

- o Percent of Hectares Affected – 10% (higher in some years)
- o Percent of Hectares Treated – No treatment currently available.
- o Potential Crop Damage – Can lose 10-20% of yield, as well as decreased quality due to seed discoloration.

iii. Pest Assessment (2,3)

▪ Monitoring

- o Monitoring should begin early in the season, well before flowering. Monitoring for any disease should be done first in fields of high risk. High risk factors are fields that had seed-borne disease present at planting (even if a seed treatment was used), fields that had chickpea in the rotation the last two years, or fields located next to infested chickpea stubble.
- o Ascochyta blight symptoms include brown lesions on the stems, leaves and pods. The lesions are light or dark brown in the center, and are surrounded by a darker brown border. Within the lesion, small brown or black round structures form (pycnidia). Even if your variety has partial resistance to ascochyta blight, the resistance becomes less effective as the plant matures. There is a mapping facility that records current presence of the disease across Saskatchewan. It is maintained by Agriculture and Agrifood Canada and the University of Saskatchewan at the web address http://paridss.usask.ca/specialcrop/pulse_diseases/index.html
- o Botrytis grey mould may spread down a seed row, resulting in a series of yellow or dead seedlings. It is favored late in the season, and is common on pods, resulting in shrunken discolored seeds. Botrytis grey mould lesions may look similar to sclerotinia, but will not be soft or easily shredded, and will be covered by a dark grey, fuzzy fungal growth.
- o Root rot is most severe when soils are cool and saturated, and seedling emergence is delayed. Infected seedlings may appear healthy, but then will become yellow, wilt and die. Stems may be girdled and discolored at or just below the soil surface, roots may have rotted, and plants are pulled easily from the ground.
- o Sclerotinia stem rot will usually occur in patches, typically in heavier areas of the crop. Early signs of sclerotinia stem rot are a light green or yellow discoloration of the plant, accompanied by a lesion and rotting along the stem. Initially, sclerotinia infections are soft and wet to touch and may be covered by a white mould. The plant later becomes bleached in colour, and the infected area will easily shred apart. In some cases, fungal bodies called sclerotia will form on or in the infected area.

▪ Forecasting

- o Ascochyta blight is commonly found in chickpea producing areas, especially in high moisture years.
- o Botrytis grey mould will be most severe in a season with high moisture conditions late in the season. A dense canopy will also give optimum development conditions for the disease (reduced airflow will keep the plant tissue moist).
- o Root rot will be worst in years when there is excessive moisture at seeding, with cooler conditions.
- o Sclerotinia stem rot infection rates will be limited if conditions are hot and dry. Higher moisture conditions, with a thicker crop canopy are ideal for disease growth.

▪ Use of Thresholds

- o Saskatchewan Crop Insurance will only insure a crop if the amount of seed borne ascochyta blight on the treated seed is maximum 0.3%. The recommendation for the

amount of seed-borne botrytis grey mould and sclerotinia stem rot combined on an untreated seed sample should not exceed 10%.

- o Ascochyta blight - There are no economic thresholds for ascochyta blight in-crop, since any sign of the disease is enough to spray with an in-crop fungicide due to its extremely aggressive nature.
- o Sclerotinia stem rot – There are no treatments for sclerotinia stem rot.
- Availability of Information/Advisory Sources
 - o Saskatchewan Agriculture and Food has disease assessment and production information available to producers, either online or from local agriculture offices.

iv. Pest Management (2,3,6,7)

Preventive Measures

- Cultural practices
 - o Adhering to proper rotations is one of the best preventative measures for all diseases.
 - o Ascochyta blight – Damage can be minimized by using disease free seed, treating seed, adhering to proper rotations, and not planting the new crop beside a field from last year that had the disease (minimizing infection by air-borne ascospores). Infected chickpea straw should be deep ploughed to hasten decomposition. Choosing varieties with ascochyta blight resistance is also very important.
 - o Botrytis grey mould – Producers can minimize damage by using disease free seed, treating seed, and adhering to proper rotations.
 - o Root rot – Producers should be sure to seed into a warm, slightly moist, well drained seed bed, at proper depths to ensure quick emergence.
 - o Sclerotinia stem rot is a common disease with other host crops so proper rotations with these crops are the best preventative measure.
- Quarantine measures
 - o None applicable.

Reactive Measures

- Chemical control
 - o Ascochyta blight - A seed treatment such as Crown® (carbathiin and thiabendazole) will help control minor levels of seed-borne ascochyta blight. An application of an in-crop fungicide such as Bravo 500® (chlorothalonil) at early flower (with a possible second application at podding) can help decrease the damage. Bravo 500® is a preventative fungicide, and will not stop infections once they have started. It is effective for 10-14 days.
 - o Botrytis grey mould - A seed treatment such as Crown ® (carbathiin and thiabendazole) will help control seed-borne botrytis grey mould.
 - o Root rot - A combined seed treatment such as Crown® (carbathiin and thiabendazole) and Apron FL ® (metalaxyl) will provide protection against most root rots.
 - o Sclerotinia stem rot - There is no seed treatment or in-crop chemical fungicide currently available for chickpea.
- Biological control and biopesticides

- o None currently available.
- Other control measures
 - o None currently available.
- Availability of IPM and/or ICM programs
 - o Ascochyta blight is such an aggressive disease, that IPM practices (which include non-chemical, cultural practices as listed above) must be combined with chemical treatments to save the crop.
 - o Botrytis grey mould – The seed treatment that controls botrytis grey mould is the same seed treatment that controls ascochyta blight, which is required for production in Saskatchewan. The other IPM measures (see cultural practices above) will also help limit the severity of the disease.
 - o Root rot – If root rot hasn't been present in other host crops, the use of IPM measures as listed in the cultural practices above should be sufficient to limit losses to root rot.
 - o Sclerotinia stem rot – There are no chemical treatment options for sclerotinia stem rot in chickpea.

Table 3 - Summary Information on Chickpea Diseases

Average Yield Losses						
Disease	% ha Infected	% ha Treated	Tonnes	CDN \$	Average % Efficacy of Control Methods*	Problem Priority Level
Ascochyta Blight	90%	seed-treatment 98% in-crop kabuli 100% desi 50%	20% (100,000)	\$41,000,000	seed-treatment (C) carbathiin and thiabendazole - 90%; in-crop (C) chlorothalonil - 70%	1 (yield, quality)
Botrytis Grey Mould	10-20%	seed-treatment 98%	3% (15,000)	\$6,150,000	seed-treatment (C) carbathiin and thiabendazole - 95%	3 (yield, quality)
Root Rot	90%	seed-treatment kabuli 98% desi 50%	3% (15,000)	\$6,150,000	seed-treatment (C) metalaxyl - 85%	2 (yield)
Sclerotinia Stem Rot	10%	-	3% (15,000)	\$6,150,000	cultural practices - 50%	4 (yield, quality)

* C - conventional; R - reduced-risk, EPA listing; Cu - cultural practices; B - biological, EPA listing

** Rated from 1 (highest priority) to 4 (lowest priority)

NOTE: This crop is not broken down by region because the crop is virtually all grown in Saskatchewan and in adjoining areas of Alberta

Source: Saskatchewan Agriculture estimates.

D – Weeds

i. Summary

A complete summary of critical needs is given in *Section V-Critical Needs*. Chickpea competes poorly with weeds. Also, the number of weed control options for chickpea is limited, so broadleaf weeds, as well as volunteers and perennials are a major issue.

Another major issue chickpea producers have to consider regarding weeds is past use of herbicides, and their residual in the soil. Chickpea is very sensitive to residual from several commonly used herbicides.(2,3,6) Examples of some of these restrictions, and the amount of months after application before you can grow chickpea, are:

- 2,4-D (2,4-D; do not use in the spring)
- Accord® (quinclorac; 24 months)
- Ally® (metsulfuron methyl; 48 months)
- Amber ® (triasulfuron; 48 months)
- Assert® (imazamethabenz; 24-36 months)
- Attain/Trophy® (fluroxypyr; 22 months)
- Banvel II ® – high rate (dicamba; 12 months)
- Curtail M® /Eclipse® /Prevail® /FlaxMax® /Lontrel® /Prestige® (clopyralid; 22 months)
- Everest ® (flucarbazone-sodium; 24 months)
- Muster ® (ethametsulfuron-methyl; 22 months)
- Prepass® (florasulam; 12 months)
- Pursuit/Odyssey ® (imazethapyr; 12 months)
- Reflex® (fomesafen; 12 months)
- Tordon® (picloram acid; 60 months)
- Unity ® (bromoxynil and triasulfuron; 12 months)

ii. Key Factors by Weed or Group of Weeds

- Broadleaf Weeds (2)
 - Commonly Found Weed Species in Chickpea Producing Areas – Wild buckwheat (*Polygonum convolvulus*), kochia (*Kochia scoparia*) and Russian thistle
 - Biology – These broadleaf weeds are annual weeds, which can cause yield losses if not controlled early.
 - Percent of Hectares Affected – 100%
 - Percent of Hectares Treated – 100%
 - Potential Crop Damage – Up to 50% yield loss if high weed pressure.
- Grassy Weeds(2)
 - Commonly Found Weed Species in Bean Producing Areas – Green foxtail (*Setaria viridis*), yellow foxtail (*Setaria glauca*), wild oats (*Avena fatua* L.)
 - Biology – These grassy weeds are annual weeds, which can cause yield losses if not controlled early.
 - Percent of Hectares Affected – 100%
 - Percent of Hectares Treated – 100%
 - Potential Crop Damage – Up to 50% yield loss if high weed pressure.
- Perennials(2)
 - Commonly Found Weed Species in Bean Producing Areas – Canada thistle (*Cirsium arvense*), sow thistle (*Sonchus arvensis*), quack grass (*Elytrigia repens*)
 - Biology – Perennial weeds tend to have extensive creeping rootstock, which frequently produces shoots that will then produce a new plant. They also tend to readily regenerate through either seed germination, or root fragments (normally they can regenerate from as little as an inch of root fragment). Most of the perennial weed seeds will germinate within a year, but some may remain viable in the soil for up to twenty years or more.

Due to their perennial nature, they are hard to control since the entire plant including rootstock must be killed in order to prevent re-growth. Control of these perennial weeds should be done in the year previous to bean production.

- o Percent of Hectares Affected – 100%
- o Percent of Hectares Treated – 100%
- o Potential Crop Damage – Up to 50% yield loss if high weed pressure.
- Volunteer Crops (2)
 - o Problem Volunteer Crops in Beans – Canola and mustard
 - o Biology – Volunteer crops are annual weeds, which can cause yield losses if not controlled early.
 - o Percent of Hectares Affected – 10%
 - o Percent of Hectares Treated – 0%
 - o Potential Crop Damage – Up to 30% yield loss if high weed pressure.

iii. Pest Assessment (2,3,7)

- Monitoring
 - o It is best to begin monitoring for weeds immediately after seeding, since herbicides cannot be applied after the plants are 2.5” (when vines have 1-3 above ground nodes).
- Forecasting
 - o No formal models available.
- Use of Thresholds
 - o None available.
- Availability of IPM and/or ICM Programs
 - o Best control measures are keeping fields clean in years outside of chickpea production.

iv. Pest Management (2, 3, 7)

Preventive Measures

- Cultural practices
 - o Seed into fields with low weed pressure, since there are limited chemical control measures available.
 - o Volunteers – The best practice is to have a cereal between your canola/mustard crop, and control all volunteer weeds in the cereal crop.
- Quarantine measures
 - o None applicable.

Reactive Measures

- Chemical control
 - o Annual weeds can be partially controlled with a pre-seeding burn off with a glyphosate product.
 - o Broadleaf weeds – Sencor ® (metribuzin) is the only broadleaf chemical registered for chickpea, and the amounts of weeds it will suppress (not control) is limited.
 - o Grassy weeds – An application of Poast Ultra® (sethoxydim), or a similar product, can give good control of grassy weeds.

- o Perennial & volunteer weeds – There are no control measures available for perennial weeds or volunteer canola/mustard in crop.
- Biological control and biopesticides – None currently available.

Table 4 - Summary Information on Chickpea Weeds

Weeds	Average Yield Losses				Average % Efficacy of Control Methods*	Problem Priority Level
	% ha Infected	% ha Treated	Tonnes	CDN \$		
Broadleaf	100%	100%	50% (250,000)	\$102,500,000	metribuzin (C) - 50%	1 (yield)
Grassy	100%	100%	6% (30,000)	\$12,300,000	sethoxydim (C) - 90%	2 (yield)
Perennial	65%	-	6% (30,000)	\$12,300,000	-	4 (yield)
Volunteers	10%	-	2% (10,000)	\$4,100,000	-	3 (yield)

* C - conventional; R - reduced-risk, EPA listing; Cu - cultural practices; B - biological, EPA listing

** Rated from 1 (highest priority) to 4 (lowest priority)

NOTE: No information specific to proportion at action threshold is available
Source: Saskatchewan Agriculture estimates

- Other control measures – None currently available.
- Availability of IPM and/or ICM programs – Not available.

E – Insects and Mites

i. Summary

A complete summary of chickpea insect priorities is found in *Section V – Critical Needs*.

Generally, insects are not a major problem in chickpea. Chickpea leaves, stems and pods are hairy and secrete malic acid, which makes the plant less attractive to insects. While there have been some insects reported to be pests in chickpea, the damage is very limited. There are currently no chemical insect control options available to chickpea producers in Saskatchewan.

ii. Key Factors by Pest (2,3,6)

- Alfalfa Looper (*Autographa californica*)
 - o Host Crops – Alfalfa, beans, clover, peas, potatoes, sugar beets
 - o Biology – Alfalfa looper overwinters as pupae in the soil, or in trash near the base of the host plant. Moths begin emerging in spring. Eggs are usually deposited singly on weed hosts, particularly wild mustards. They hatch in 3 to 5 days and the larvae feed for about 2 weeks before pupating in cocoons on the host plant or in plant debris. The total development time from egg to adult requires about 30 days. The second-generation adults emerge shortly afterwards. There are two to three generations each year. Larvae of the second generation cause the most serious damage.
 - o Percent of Hectares Affected – Sporadic but could become a problem as acres and years grown increase
 - o Percent of Hectares Treated – No treatment available.
 - o Potential Crop Damage – If significant in field, 10-20% loss

▪ Cutworm

- o Host Crops - The red-backed cutworm feeds on practically all field crops, vegetables, and home garden plants. It is best known for its' feeding on cereals, flax, sugar beets, canola, and mustard. The army cutworm feeds on the foliage of wheat, oats, barley, mustard, flax, alfalfa, sweet clover, field peas, cabbage, sugar beets, corn, oats, potatoes, various weeds (notably stinkweed) and grasses. Almost any crop, present during the early spring, could be a potential host.
- o Biology – There are many different species of cutworms, but the most common ones are the red-backed cutworm (*Euxoa ochrogaster (guenee)*) and the army cutworm (*Euxoa auxiliaris (Grote)*). Cutworm moths may lay several hundred eggs on their host plants. After the eggs hatch, the larvae feed on the host plants. They moult several times, eventually reaching about 5 cm (2 in.) in length. The larvae tunnel into the soil to form earthen cells where they pupate. The new moths emerge, exiting through the soil using the old larval tunnels. Some species overwinter as eggs (e.g., the red-backed cutworm); others, as larvae or pupae. Still others do not overwinter in the Prairies but rather reinvade annually from the USA, aided by southerly winds. Most of our pest species have only 1 or 2 generations per year.
- o Percent Hectares Affected – Sporadic (around 5%) acres affected, usually in patches in the field
- o Percent of Hectares Treated – No treatment available.
- o Potential Crop Damage – Patch areas would be wiped out (may cause around 5% overall yield loss)

▪ Grasshopper

- o Host Crops – Grain and forage crops
- o Biology – There are several species of grasshoppers that are serious pests of grain and forage crops in Western Canada. Eggs are laid in packet-like bunches ½-2 inches below the surface of the soil. They are mainly deposited in uncultivated ground such as field margins, pasture land and roadsides. They may also be laid in considerable numbers in clover, alfalfa, and stubble fields. There are usually five or six nymphal instars that require about 1-2 months to reach the adult stage. Growth is usually completed in the late summer. A late spring or cool summer may delay development so that nymphs are present through the autumn. Adult feeding can continue until the first heavy frost. The eggs are mainly deposited during August and September, where they overwinter and begin hatching in May through June.
- o Percent Hectares Affected – Early seedling stage when very heavy infestation year, but this isn't very common (1 in 10 years)
- o Percent of Hectares Treated – No treatment available.
- o Potential Crop Damage – Quite high (50%) if hits at early seedling stage

▪ Wireworm

- o Host Crops – Prefers annual and perennial grasses, canola, cereals, corn, potatoes, sugar beets, sunflower
- o Biology – Wireworms are larvae of a group of beetles commonly called click beetles. There are almost 400 species of wireworms found across Canada. While most are harmless, several species are serious pests. The larval stage of wireworms requires from two to six years or more to complete. When fully grown, usually in July, the larvae pupate about 5 to 10 cm below the soil surface. Pupation lasts for less than a month;

however, adults do not emerge until the following spring. Wireworms often burrow into shoots causing plants to appear stunted, wilt or die

- o Percent Hectares Affected – Sporadic (around 5%) acres affected, usually in patches in the field
- o Percent of Hectares Treated – No treatment available.
- o Potential Crop Damage – Patch areas would be wiped out (may cause around 5% overall yield loss)

iii. Pest Assessment (2,6)

▪ Monitoring

- o There is really no monitoring for insects, since there are no chemical control measures available.

▪ Forecasting

- o Need to watch out for the Alfalfa Looper, since its levels could increase as more chickpea acres are grown year after year.
- o If early, high levels of grasshoppers are forecasted producers may not seed chickpea since they have no control options. Grasshopper forecasts are available at the following web URLs;

http://www.gov.mb.ca/agriculture/crops/insects/forecast/grasshopper_map.html

http://www.agr.gov.sk.ca/DOCS/crops/integrated_pest_management/insects/images/hoppermap2003.gif

and http://www.agric.gov.ab.ca/pests/forecast/2003hopper_forecast.html

iv. Pest Management (2,3,6)

Preventive Measures

- Cultural practices
 - o Limiting the amount of host crops in a rotation (if possible).
- Quarantine measures
 - o None applicable.

Reactive Measures

- Chemical control
 - o None available.
- Biological control and biopesticides
 - o None currently available.
- Other control measures
 - o A virus will usually control late-season infestations of alfalfa looper.

- Availability of IPM and/or ICM programs
 - No established IPM programs.

Table 5 - Summary Information on Chickpea Insects

Weeds	% ha Infected	% ha Treated	Average Yield Losses		Average % Efficacy of Control Methods*	Problem Priority Level
			Tonnes	CDN \$		
Alfalfa Looper	3%	-	-	-	-	3 (yield)
Cutworm	5%	-	2% (10,000)	\$4,100,000	-	1 (yield)
Grasshopper	2%	-	-	-	-	2 (yield)
Wireworm	5%	-	2% (10,000)	\$4,100,000	-	1 (yield)

* C - conventional; R - reduced-risk, EPA listing; Cu - cultural practices; B - biological, EPA listing

** Rated from 1 (highest priority) to 4 (lowest priority)

NOTE: Information on proportion of crop at or over the action threshold is not available.

Source- Saskatchewan Agriculture and Food estimates

F- Other Animal/Vertebrate Pests

No other animal or vertebrate pests are an issue in chickpeas.

Table 6 - Summary Information on Control Products and Pests

Product	% ha Treated	Rate	Timing & Frequency	Cost / ha	% Control	PHI/REI*	IPM Compatibility**
Crown (fungicide for disease)	100%	0.075-0.15 L / 25 kg seed	seed-treatment	\$24-33	90%	-	-
Apron FL (fungicide for disease)	kabuli 98% desi 50%	0.016-0.11 L / 100 kg seed	seed-treatment	\$20-28	90%	-	-
Bravo (fungicide for disease)	kabuli 100% desi 50%	3-4 L / ha	early flowering	\$12-23	70%	48 days/ 48 hours	-
Poast Ultra	100%	0.47 L / ha	weeds in 1-6 leaf stage	\$11	90%	65 days / 48 hours	-
Sencor	100%	0.41 L / ha	plants are 2.5"	\$18	50%	70 days / 48 hours	-

* PHI - Pre-harvest interval (days); REI - Re-entry interval (hours)

** R+ - resistance management alternative; RP - alternative to Ops; I - IPM compatible; T - trade issue; Re - losing registration

Source – Saskatchewan Agriculture and Food, Saskatchewan Agriculture Guide to Crop Protection 2003

NOTE 1: There is no information regarding the proportion of each pest problem that is over the action threshold.

NOTE 2: Table 6- Percent treated figure is estimate from Saskatchewan Agriculture and Food

NOTE 3: All of the products in the table are compatible with IPM but require work on economic thresholds.

Table 7. Summary information on IPM control methods

Pest type	Method type	Estimated % efficacy	Cost per ha	% Adoption	Comments
Weeds (annual)	Preseeding tillage (C)	30%	\$10 +/-ha fuel	<20	Will control early germinating weeds. Much of the production is in low organic matter brown soil zones and the practice may be destructive to soil on erosion prone areas
Seed borne diseases	Certified seed use (C)	20 – 30 %	\$ 20/ha	50 to 100	Rapid acreage expansion has led to seed shortages in the past and use of farm saved seed
Diseases, weeds and insects	Economic threshold spraying (C)	100 %	\$5	<10	Poor adoption due to lack of information.
Weeds	Delayed or early seeding	10%	\$0 to \$50	<10	Chickpeas require a long season and thus seeding time manipulation for pest control is of minimal use.
Diseases	Crop rotation every four years (CR)	60 – 100%	N/a	80%	Most growers adhere to rotation but some will push rotations if economics dictate tighter rotations

Source – Saskatchewan Agriculture and Food estimates

VI Critical industry needs

In June 2002 at Saskatoon, chickpea growers and grower support interests at a prioritization meeting developed the following critical needs. The list of participants who developed these is given in Appendix B.

Research

- Enhance ascochyta-resistance breeding programs
- Improved control management tools and practices for ascochyta
 - o Modeling/forecasting tool
 - o Fungicide chemistry
 - o Fungicide rotations
- Breeding for early maturity
- Broadleaf weed control tools
- Improved harvest management tools (desiccants, growth regulators, defoliant)

Regulatory

- Label expansion for ethafluralin, diquat, imi's
- Register sulfentrazone and strobilurins
- Harmonize (with U.S.) and streamline registration process
 - o Compressing trial zones
 - o Increase acceptance of U.S. data
 - o Expedite setting up a Canadian IR-4
- Pulse industry to work with PRMA on regulatory flexibility to maintain pulse crops in the minor use system, to obtain product registration in pulse crops
- Industry to explore potential of picking up minor pesticides
- Coordination within Canada to generate data to fill requirements for minor use registrations
- Examine "novel trait" plant definition

Education

- Educate on disease management, resistance management, disease identification and field scouting
- Stakeholder awareness of regulatory requirements for pulses
- Educate on rotations and other cultural pest management strategies
- Educate on pesticide persistence
- Develop crop profiles
- Harmonize (with U.S.) and streamline registration process
 - o Compressing trial zones
 - o Increase acceptance of U.S. data
 - o Expedite setting up a Canadian IR-4
- Pulse industry to work with PMRA on regulatory flexibility to maintain pulse crops in the minor use system, to obtain product registration in pulse crops
- Industry to explore potential of picking up minor pesticides
- Coordination within Canada to generate data to fill requirements for minor use registrations

General

- Develop super-crop groupings
- Pesticide harmonization
- Additional IPM crop protection tools for disease
- Additional IPM crop protection tools for broadleaf weeds
- Work with int'l trade partners so that MRLs don't become trade irritants
- Catch up pesticide registration and on-farm food safety; develop list of products that need to be registered
- Re-evaluate zone maps for residue trials
- Crop profiles

- Define, monitor, and document IPM practices in pulses
 - o Educate regulators
 - o Educate public

VI Actual research areas

The following trials, registered with ICAR and studies related to agronomy and pest management were in progress as of 2002. Note that none of these specifically address the issues under V. *Critical Needs* but these do show an important summary of the nature of the work that is going on in chickpea production.

Table 8. Chickpea projects registered with ICAR

ICAR ID	Project Title
<u>22220840</u>	Practical Control Strategies for Ascochyte (<i>Mycosphaerella</i>) Blight in Field Pea and Chickpea
<u>22221604</u>	Evaluation of chickpea cultivars for resistance to pythium, fusarium, and rhizoctonia root rot
<u>22221613</u>	Special crops regional variety tests
<u>33330082</u>	Seed treatment with fungicides to control root rot diseases of chickpea
<u>33330090</u>	Effect of seed size on seed yield and maturity of dry beans and chickpeas
<u>33330476</u>	Improvement of Chickpea Disease Control Through Spray Application Delivery Method
<u>33330583</u>	Management of Foliar Diseases (<i>Mycosphaerella</i> Blight and Powdery Mildew)
<u>33330800</u>	Foliar spray of fungicides to control ascochyta blight of chickpea
<u>33330885</u>	Stabilizing yield and quality: early maturing chickpea for the prairies
<u>33331018</u>	Development of cost-effective fungicide application strategies for the control of ascochyta blight in chickpea
<u>33331038</u>	Development of chickpea for Saskatchewan
<u>90000581</u>	TagTeam: A combined rhizobium/phosphate inoculant.
<u>96005035</u>	BIOLOGICAL CONTROL OF WEEDS USING MICROORGANISMS

Source – ICAR website accessed March 1, 2003

VIII Available resources

The following institutions have active pulse research programs or are capable of researching the production of chickpeas. Although these institutions may not be specifically working on projects

identified under *V. Critical Needs*, they do represent the key resourcing that is available in implementing strategic pest management plans.

Institution	Areas of expertise
Scott Research station, Scott, SK	Agronomy/weeds
University of Saskatchewan, Saskatoon, SK	Weeds/Agronomy/Breeding/Pathology
Swift Current Research Station, Swift Current, SK	Agronomy
Indian Head Research Station, Indian Head, SK	Agronomy/Weeds

The following websites have information on pulse crop production and crop protection.

Production information - www.saskpulse.com

Markets and general information - www.pulsecanada.com

Production and marketing statistics - www.statcan.ca

Production information - www.gov.mb.ca/pulse/agriculture/crops/pulsecrops

Production information - www.pulse.ab.ca

Production information - www.agric.gov.ab.ca/navigation/crops/pulses/

Production and marketing - www.agr.gov.sk.ca

Quality and grading - : <http://www.cgc.ca/main-e.htm>

References

1. United Nations Food and Agricultural Organization website <http://apps.fao.org> accessed February 12,2002
2. Ray McVicar, Pulse Specialist, Saskatchewan Agriculture and Food
3. Saskatchewan Agriculture and Food website; www.agr.gov.sk.ca accessed February 15, 2003
4. Canadian Grain Commission publication “Grading Standards for Canadian Crops”
5. Pulse Canada, ‘Chickpeas Market Information’
6. Saskatchewan Agriculture and Food Publication ‘Guide to Crop Protection 2003’
7. Saskatchewan Agriculture and Food – ‘Chickpeas in Saskatchewan’
8. Saskatchewan Agriculture and Food – ‘Ascochyta Blight in Pulse Crops’
9. Saskatchewan Agriculture and Food ‘Crop Planning Guide’
10. Agriculture and Agrifood – Pulse Crop Diseases website (http://paridss.usask.ca/specialcrop/pulse_diseases/index.html)
11. CARC website of ongoing research by commodity <http://www.carc-crac.ca/english/index.htm>
12. Grasshopper forecasting sites are found at the links listed below

http://www.gov.mb.ca/agriculture/crops/insects/forecast/grasshopper_map.html

http://www.agr.gov.sk.ca/DOCS/crops/integrated_pest_management/insects/images/hoppermap2003.gif

Trademark usage

Trademarks used are followed by a ®. These include the following products: Accord® Pursuit®/Odyssey® Reflex® - BASF Canada Ally® and Muster® - Dupont Canada Amber® Unity® Crown® -Syngenta Assert® Attain/Trophy® Tordon® -Dow Agrosiences Banvel II® – BASF Canada, Curtail M® /Eclipse® /Prevail® /FlaxMax® /Lontrel® /Prestige® - Dow Agrosiences, Everest® - Arvesta Corp Crown® Apron®- Gustafson

Appendix A – Canadian Grain Commission Chickpea Standards (2002)

Primary and export grade determinants for Kabuli chickpeas

Grade name	Colour	Damage %	Splits/mechanical damage	Green %	Foreign material
No 1 CW	Good, natural	0.5	1.0	0.5	0.1
No. 2 CW	Fair	1.0	2.0	1.0	0.2
No. 3 CW	Poor	2.0	3.0		

Primary and export grade determinants for Desi chickpeas

Grade name	Colour	Damage %	Splits/mechanical damage	Green %	Foreign material
No 1 CW	Good, natural	1	2	1	0.1
No. 2 CW	Fair	2	3.5	2	0.2
No. 3 CW	Poor	3	5	3	0.2

Appendix B

Critical Needs and agronomy sections

NAME	ORGANIZATION	CATEGORY	EMAIL
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