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Growing Chickpea in the northern Great Plains

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This publication is intended for growers considering either desi or kabuli chickpea as a crop. The text covers basic market information, plant growth habit, crop production, field selection, seedbed preparation, fertilization, inoculation, seeding, control of weeds, diseases and insects, rotational benefits and harvesting.

Chickpea is a high-value crop that is adapted to deep soils in the semiarid northern Great Plains. However, disease risks are high and thus this crop is recommended only for producers who are willing to develop excellent management skills.

Ascochyta blight, a foliar disease, caused devastating financial losses for many growers in 2001. Of 46,500 acres seeded in Montana and North Dakota, only 30,000 acres were harvested. This will likely be a recurring problem, so pay special attention to the section on disease management.

Currently chickpea is considered a 'vegetable' crop, so check with your local Farm Service Administration office before seeding to learn if it is legal for you to grow this crop.

Introduction

Chickpea *(Cicer arietinum L.)* is an annual grain legume or 'pulse' crop sold into human food markets.

Chickpea is classified into 'desi' or 'kabuli' types based primarily on seed color. Desi chickpea has a pigmented (tan to black) seed coat and small seed size (>100 seeds/oz). Kabuli chickpea, sometimes called "Garbanzo bean," has white to cream-colored seed coats and range in size from small to large (> 100 to < 50 seeds/oz).

Before selecting a cultivar, contact potential buyers to ensure it is accepted in the market you are targeting. Farm-level chickpea yields have ranged from 0 to over 2,400 lb/ac in the northern Great Plains, but yields most commonly range from 500 to 1,500 lb/ac.

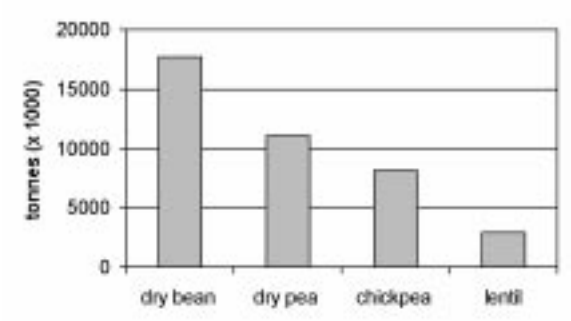

Figure 1. World production (1997–2001 avg.) of four major dryland pulse crops

World production

From 1995 to 1999, India, Spain, Pakistan and Algeria accounted for 50% of world chickpea imports, with many other countries importing small percentages.[1] World chickpea production is roughly three times that of lentil, and world consumption is second only to dry bean among pulse crops marketed as human food (Fig. 1).

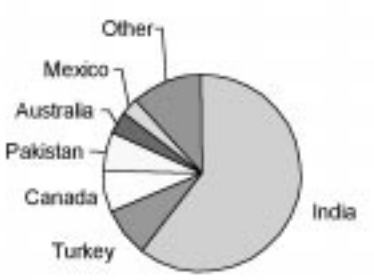

Figure 2. World distribution of chickpea production in 2001

Distribution

In 2001, six countries accounted for 90% of world chickpea production, with India alone accounting for 60% (Fig. 2). From 1995 to 1999, world chickpea exports averaged 575,000 tonnes (metric tons), with Australia, Turkey and Mexico exporting 80% of the world chickpea crop.[1]

Canadian production

Recently, chickpea production has risen rapidly in the Canadian prairies (Figure 3), and Canadian exports are expected to reach 375,000 tonnes in

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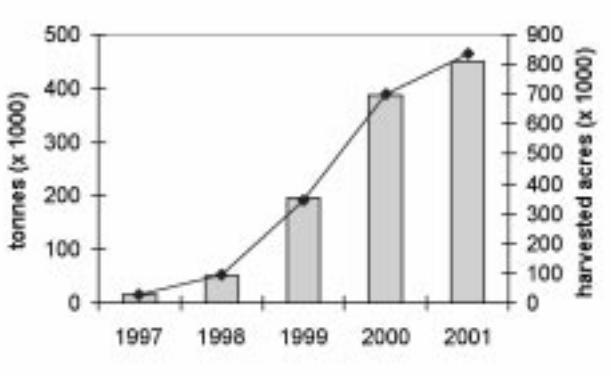

Figure 3. Chickpea production in the Canadian prairies

the 2001/02 crop year.[2] Note that only 70% of 1.2 million seeded acres were harvested in Canada, highlighting the production risk for chickpea. In 2001, 134,000 acres of chickpea were grown in the USA.

Price uncertainty

Producers of alternative crops such as chickpea face questions of price expectation in addition to the production uncertainty that is discussed extensively in this report. This price uncertainty is a particular problem with chickpea since acreage in non-traditional areas such as Canada is growing rapidly. Additionally, chickpea production must compete with wheat, where government loan programs and crop insurance provide substantial benefits to wheat production not currently provided for crops such as chickpea.

Researching buyers

Although many opportunities exist for contracting chickpea production with both U.S. and with Canadian buyers, producers should be careful to understand all terms of the contract, particularly in terms of quality measurements and dispute resolution. The chickpea market, like that for other alternative crops, is undergoing significant changes with many firms entering and leaving the industry every year. Be certain to research the reputation of firms you consider contracting with.

Insurance

Insurance for alternative crops in general, and chickpeas in particular, for managing production risk is currently being developed. For some alternative crops, Risk Management Agency (RMA) actuarial tables are available in some counties. In the absence of RMA crop actuarial tables, an individual producer may file a request for actuarial change which, when successful, results in a written agreement specific to the given alternative crop for that producer. Finally, producers may rely on the Farm Service Agency's Non-Insured Crop Disaster Assistance Program (NAP). Any insurance product for chickpeas is likely to reflect the crop's relatively high production and price risk.

Adaptation

Drought tolerance

Under drought stress conditions maturity requirements for chickpea are similar to or slightly longer than for spring wheat. However, chickpea has an indeterminate growth habit which can greatly extend maturity if cool or wet late summer conditions persist. Chickpea roots deeper than dry pea or lentil, and has greater drought tolerance when stored subsoil water is available.

Temperature

Temperature optimums are not well understood for this crop and climatic requirements are not well known.[3,4] In Montana, cool growing regions might present additional risk for reaching maturity before a mid-September frost. Chickpea tolerance to frost is similar to spring cereal grains. Chickpea tolerates high temperatures during flowering, unlike dry pea.

Growing season

Chickpea matures later than dry pea or lentil and prefers a longer, warmer growing season. In southwestern Saskatchewan, desi chickpea averaged 1120 degree days (base = 0 degrees C), 65 degree days (~3 to 6 days) later than Laird lentil.[5] Desi chickpea flowers one day to one week earlier than kabuli types, depending on the specific varieties being compared. Large-seeded kabuli varieties generally mature one to two weeks later than desi types, but new Canadian kabuli varieties have been bred for earlier maturity.[6] Average maturity will depend on the variety, and especially climatic conditions, ranging from 100 to 130 days.

Typically, if seeding chickpea in early May, plan to harvest by mid-September. Under cool, wet late summer conditions, maturity can be delayed substantially due to chickpea's indeterminate growth habit, and producers must manage to meet market specifications for green seed content (< 0.5% to receive U.S. No. 1 grade, USA Dry Pea and Lentil Council). Rapidly expanding production experience in Canada has shown that understanding the climatic conditions that favor the common and problematic disease in this crop, Ascochyta blight, is as important as understanding the climatic requirements for chickpea growth.

Plant Growth Habit

The chickpea plant is erect with primary and secondary branching, resembling a small bush. There are two leaf types, the 'fern' leaf with multiple leaflets attached to a leaf stem, and the single or 'unifoliate' leaf that is present on some kabuli varieties. The plant flowers profusely and has an indeterminate growth habit, continuing to flower and set pods as long as climatic conditions are favorable.

Desi and kabuli chickpea types can be easily identified by flower color, with desi types having purple flowers and kabuli types having white flowers, corresponding with the presence or absence of pigmentation in their respective seed coats. The pods are individual and oval and typically contain one to two seeds. Plant height typically ranges from 10 to 22 inches, with kabuli types often slightly taller than desi types. The lowest seed pods are typically 4 to 6 inches from the soil surface under dryland conditions.

Cultural Practices – Crop Production

Optimum yield potential and success in chickpea production is obtained by giving complete attention to field selection, seeding, inoculation, disease control, weed management, insects, harvesting and crop rotation. Disease management is critical to success and potential growers are advised to obtain a copy of the MontGuide, *Ascochyta Blight Management in Chickpea* when it becomes available in spring 2002.[7]

Field Selection

In areas receiving less than 13 inches of annual precipitation, chickpea is best suited for production on summerfallow owing to its ability to capitalize on deep stored soil water via its rooting system.

Seed size is a critical marketing factor for large kabuli types and production on fallow might be critical to ensuring water supply late in the growing season when seed size is finally set.

Some producers have noted that plant development and maturity is more even in fallow compared with stubble fields. In areas of higher rainfall, or where concern for Ascochyta blight is high, chickpea should be grown as a stubble crop.

Chickpea is not well suited for production on soils with shallow structure. Little information is available for chickpea production under irrigation in the northern Great Plains environments, but early experience in southern Alberta[8] and central Montana suggests it is a viable practice provided Ascochyta blight can be successfully managed.[7]

To select appropriate fields for chickpea, consider previous herbicide use (see Table 1), weed spectrum and pressure, interval since chickpea was last grown, and proximity to current and past chickpea fields. These considerations are critical to manage weeds and diseases and to minimize residual herbicide injury to the crop. Avoid fields that have a history of perennial weeds such as Canada thistle and field bindweed.

For integrated disease management, start by selecting a field that has not had chickpea for at least three years and is at least three miles from previous year's fields. However, even with these precautions, any chickpea field should be considered susceptible to Ascochyta blight during wet periods since long-distance spore transmission appears to have occurred frequently in the past two years, and was especially widespread in 2001. Fields that are well drained are preferred, as chickpea suffers plant injury from waterlogged soil relatively quickly compared with other non-legume broadleaf or cereal crops.

Many herbicides used in small grain production can carryover resulting in chickpea injury and yield loss (see Table 1). Rotational interval to chickpea depends on how long herbicides remain in the soil. Factors that affect herbicide persistence include pH, moisture and temperature. Because Montana and western North Dakota have dry climates and short growing seasons, herbicides generally degrade slower than in warmer, wetter areas. Sulfuron herbicides (Ally, Ally Extra, Amber, Finesse, Glean, Peak and Rave) persist longer in high pH soils. In areas with low rainfall and high soil pH (>7.5), sulfuron herbicide residues may remain in the soil much longer than described on the label, and a soil bioassay should be considered for any suspected herbicide residue.

Herbicide	Interval between application and planting chickpea	Minimum precipitation/ %OM
Ally	34 months *	28 inches
Ally Extra	22 or 34 months*	18 or 28 inches
Amber	bioassay	
Assert	15 months	
Canvas	22 or 34 months *	18 or 28 inches
Curtail	18 months	15 inches/ 2% OM
Finesse	bioassay	
Glean	bioassay	
Peak	22 months	
Rave	bioassay	
Stinger	18 months	15 inches/ 2% OM
Tordon	bioassay	

** indicates a field bioassay is required. See product label for specific guidelines.*
*** length of Tordon carry-over depends on application rate, application frequency, soil type and environmental conditions following application.*

Table 1. Minimum herbicide rotation intervals

Seeding

Optimal seeding dates for chickpea remain unknown, especially for Ascochyta blight management. Producer experience suggests that both types of chickpea can be seeded as early as other pulse crops (dry pea, lentil) but it is essential that kabuli types are treated with metalaxyl (Allegiance, Apron) seed treatment to prevent Pythium seed rot. It is also essential that high quality seed free of Ascochyta (<0.3%) be used, and thiabendazole (LSP) seed treatment is recommended as part of an effective plan for integrated Ascochyta blight management.

Air drills and openers often need minor modifications and adjustments to avoid seed damage and to facilitate the metering of large kabuli seed.

Chickpea is typically seeded in narrow row spacings of 6 to 12 inches. Target stand densities range from 3 plants per square foot for large kabuli types to 4 plants per square foot for desi and small kabuli types. This will typically require planting 4 seeds/sq.ft. for large kabuli and 5 seeds/sq.ft. for

desi chickpea. Depending on seed size this often translates into seeding rates of 80-100 lb/a for desi types and 125-150 lb/a for large kabuli types.

Seeding depth recommendations are 1 inch below moist soil for small-seeded types and 2 inches below moist soil for large-seeded types. Chickpea can be seeded to a depth of 4 inches to utilize available soil moisture for germination.

Fertilization

Nutrient requirements of chickpeas are not well understood. With effective rhizobial inoculation, application of nitrogen is generally unnecessary unless available soil nitrogen levels are below 15 lb/a. When below this level, application of no more than 18 lb/a of additional nitrogen (which must not be applied directly with the seed) is recommended.

Some growers have reported chickpea yield increases associated with high soil N status but research studies in Montana and Saskatchewan have not shown a yield benefit to high rates of fertilizer N.[9,10]

It is expected that chickpea will respond to phosphorous, sulfur, molybdenum, manganese and iron if these nutrients are deficient. Phosphorous can be safely applied in the seed row up to rates that are used for wheat.

If the field requires rolling, the operation should be completed immediately after seeding or after the plants are well emerged, but before the 6-leaf stage of growth. Do not roll during plant emergence.

Inoculation

Chickpea must be inoculated with a specific Rhizobium strain for Cicer species to ensure effective nodulation and nitrogen fixing activity.

Inoculant is marketed in granular, liquid and powder forms for seed inoculation or in granular form for soil inoculation. The powder and granular formulations can consist of clay or peat.

Seed-applied inoculant must be applied to the seed immediately prior to planting. Large populations of introduced rhizobia bacteria must survive in the harsh soil environment for 2–3 weeks in order to effectively form nodules on the roots of pulse crop seedlings.

In dryland cropping regions, peat granular inoculant is preferred since it is more reliable in dry seedbed conditions.

Disease control

Ascochyta blight is the most serious threat to chickpea production[11] and many Montana, North Dakota and Canadian growers suffered large economic losses due to this disease in 2000 and 2001.

The pathogen survives in infected seed and on infected residue.[12] The epidemiology of this disease remains poorly understood and growers should prepare to manage this disease with foliar fungicides regardless of prior field history or seed sanitation measures.

If weather conditions are conducive to disease development (rainy spells, periods of prolonged high humidity), expect Ascochyta blight to occur. In 2000 and 2001 Ascochyta inoculum apparently traveled very long distances to severely infect fields where the crop had not been previously grown and where disease-free seed was planted and precautionary seed treatment (thiabendazole (LSP)) was used.

Unifoliate kabuli varieties (CDC Xena, Dwelley, Evans, Sanford) have low levels of tolerance and are considered high risk for Ascochyta blight unless growers are willing to commit to a season-long disease monitoring and fungicide application program. Even this might not ensure positive economic returns due to the high cost of foliar fungicides.

Detecting Ascochyta blight

Ascochyta symptoms initiate differently in different varieties, sometimes beginning as leaf lesions and sometimes as stem lesions.[7] Growers are strongly advised to scout all chickpea fields frequently and be prepared to apply fungicides less than 24 hours after detection of Ascochyta blight.[6] When field scouting, check the wettest areas of the field first and edges closest to previous fields, as symptoms most often appear in these areas first.[7] Producers need to ensure that they are able to identify early symptoms in both the leaf and stem lesion forms.

Kabuli chickpea, due to its thin seed coat, is highly susceptible to damping off and seedling blights under typical cool moist spring soil conditions. Pythium sp, and to a lesser extent Fusarium sp, both soil-borne fungi, can kill germinating seeds. Recommended seed treatments include Allegiance or Apron for Pythium prevention and Captan for a broad spectrum preventative program.

Caution needs to be exhibited when utilizing Captan seed treatments as this fungicide adversely effects Rhizobia if in contract with the seed for more than two hours.[13]

Weed Management

Chickpea is a poor competitor with weeds at all stages of growth. Slow growth during the seedling stages, in addition to a relatively sparse optimum plant population of three to four plants per square foot, causes an open crop canopy which requires season-long weed management. Crop rotation and field selection are cultural methods that should be used as part of an integrated weed management system. Cultural weed control begins with avoidance. Avoid fields where perennial and annual broadleaf weeds are a major problem, and be sure to control these weeds in the preceding crop. Kochia, Russian thistle, wild mustard and wild buckwheat are the most problematic in chickpea, and can cause major problems for direct-harvesting.

Weeds can be managed with stale seedbed techniques provided the grower is willing to risk yield loss due to delayed seeding. Stale seedbed techniques include delaying seeding, allowing weeds to emerge, then destroying them with either tillage or non-selective herbicide. Generally, the first flush is the largest, and the earliest emerging weeds are the most competitive as they consume the most soil resources. Stale seedbed techniques are not foolproof, as weeds will continue to emerge throughout the growing season and warm season annual weeds such as green foxtail (pigeongrass) may be favored by delayed seeding.

Herbicide	Application Time	Rate per acre	Weed Spectrum	Remarks
Assure II (quizalofop)	POST	8 – 10 fl oz at 1% v/v	Grass weeds	Apply with COC
Dual II Dual II Magnum (metolachlor)	PPI, PRE	1– 2 pt	Grasses –not wild oat –some broadleaves	PPI improves activity.
Fargo (triallate)	PPI	1.25 qt 12.5-15 lb	Wild oat	Buckle (Fargo + Treflan) labeled
Poast (sethoxydim)	POST	0.5-1.5 pt	Grass weeds 2–4"	Apply with COC at 1 qt/A
Prowl (pendimethalin)	PPI	1.2-3.6 pt	Grass (not wild oat) some broadleaves	Adjust rate to soil type
Pursuit W DG (imazethapyr)	PPI, PRE	2 fl oz 0.72 oz WDG	Grass and broadleaf weeds.	Severe crop injury possible
Select (clethodim)	POST	4-8 fl oz	Grass weeds (grass 2–6")	Apply with COC 1 qt/A
Sonolan (ethalfluranlin)	PPI	1.5-2pt 5.5-7.5 lb	Some annual grass and broadleaf weeds	Adjust rate to soil type
Spartan* (sulfentrazone)	30 days preplant to 3 days PRE	2-5.33 oz	Kochia, R. thistle lambsqu, pigweed, –suppress buckwheat	Adjust rate to soil type**
Tough (pyridate)	POST	1.5 pt	Small weeds, kochia, pigweed, lambsq, R. thistle	15–20 gpa
Treflan HFP Treflan 10G (trifluralin)	PPI	1-2 pt 5-10 lb	Some annual grass and broadleaf weeds	Adjust rate to soil type
Glyphosate	PREHARVEST	see label	Harvest aid and dessicant	Apply with AMS fertilizer Allow a 7-day PHI
Paraquat	PREHARVEST	see label	Dessicant	Allow a 7-day PHI

** Section 18 Emergency registration for 2001, registration pending for 2002*
*** Herbicide activity increases as organic matter decreases and pH increases*

Refer to the label prior to use for complete information on herbicide use.

Table 2. Herbicides labeled for use in chickpea in Montana and North Dakota

Several herbicides are labeled for managing weeds in chickpea (Table 2). Troublesome broadleaf weeds like kochia and Russian thistle can be controlled in no-till chickpea with sulfentrazone (*Spartan – label pending*). North Dakota State University research has shown that higher rates of sulfentrazone may be required to control wild buckwheat. Sulfentrazone can be applied from up to 30 days prior to planting to 3 days after planting. A burndown herbicide like glyphosate may be tank mixed with sulfentrazone if broadleaf or grass weeds have emerged. For optimum activity, sulfentrazone needs 0.5 inches of moisture soon after application to become activated in the soil. Soil factors such as pH, texture and organic matter content affect sulfentrazone activity in soils.

Growers should carefully consult the label or a product representative to determine optimum rates for Spartan on individual farms.

In conventional tillage systems, trifluralin (Treflan), ethalfluralin (Sonalan) and pendimethalin (Prowl) incorporated preplant will control certain broadleaf weeds plus foxtail and barnyardgrass, but not wild oat or quackgrass. Imazethapyr (Pursuit) can be incorporated preplant or preemergence to control certain broadleaf and grass weeds. However, imazethapyr will not control ALS-resistant kochia and the user assumes all risk of crop injury.

MSU research has shown high injury potential with preemergence applications of Pursuit in chickpea.

Check the label for application recommendations and restrictions.

Variety	Type[z]	Location years[y]	Yield % Dwelley[y]	Leaf type[x]	Ascochyta blight tolerance[w]	Relative maturity[v]	Seed size[u]
Dwelley	K	11 / 9	100	U	VP	VL	VL
Amit (B-90)	K	x / 8	X / 226	F	F	M	S
CDC Chico	K	7 / 8	171 / 173	F	P	E	S
CDC Xena	K	7 / x	131 / x	U	VP	M	VL
CDC Yuma	K	7 / 9	117 / 141	F	P	L	L
Evans	K	11 / x	107 / x	U	VP	L	L
Sanford	K	11 / 9	117 / 112	U	VP	L	L
Myles	D	11 / 9	188 / 260	F	F	E	VS

[z] *Kabuli or Desi.*
[y] *First number reflects Montana trials, second number reflects North Dakota trials.*
[x] *U = unifoliate, F = fern.*
[w] *VP = very poor, P = poor, F = fair.*
[v] *VL = very late, L = late, M = medium, E = early.*

Table 3. Chickpea variety evaluation in Montana (1998–2001)/North Dakota (1999–2001)*

**Ascochyta blight affected variety yield comparisons in North Dakota, and to a lesser extent in Montana.*

Pyridate (Tough) is the only postemergence herbicide labeled in chickpea that will control broadleaf weeds. Under optimum conditions, pyridate will control kochia, pigweed, lambsquarters and Russian thistle. Pyridate will not control wild buckwheat. For optimum weed control, pyridate should be applied in a high spray volume (20 gpa), in warm, sunny conditions, and to weeds 3 inches tall or less.

Tough should not be applied under cool, cloudy conditions.

Insects

Extension entomologists indicate that insect problems might become economically important in chickpea with time, and they advise producers to scout for potential insect problems when scouting for disease and weed pests. Often minor insect feeding on leaf tissues is confused with early symptoms of Ascochyta blight.[7]

Chickpea stems, leaves and seedpods are covered with small hair like glandular structures that secret malic and oxalic acids which deter insect pests. It has been observed that some grasshopper species are reluctant to feed on chickpea vegetation.

It has also been noted that chickpea fields infested with mustard will suffer some cabbage looper feeding injury on chickpea plants adjacent to mustard plants. Plant stands have been damaged occasionally by cutworms and wireworms.

Varieties

Variety evaluations for Montana and North Dakota appear in Table 3. In Montana variety trials, Dwelley chickpea yields have ranged from a 4-year average of 270 lb/ac on shallow soils at Moccasin to 1160 lb/ac on deeper soils at Huntley. Yields also ranged widely in North Dakota due to the presence or absence of fungicide application for Ascochyta blight. The average 1999–2001 yield in the North Dakota trials was 980 lb/ac.

Although all listed varieties possess some level of Ascochyta tolerance, recent experience has shown that the unifoliate varieties have very low levels of tolerance in the northern Great Plains. For this reason CDC Xena, Dwelley, Evans, Sanford and Sierra are considered high risk for production in eastern Montana and North Dakota.

CDC Yuma has slightly better Ascochyta tolerance than the unifoliate leaf types; however, seed size is smaller than the very large seeded kabuli varieties.

B-90 (Amit) currently exhibits the best tolerance to Ascochyta of all varieties and is the best adapted kabuli variety to high Ascochyta risk areas.

Desi chickpea (i.e., Myles) has shown consistent yield potential across Montana and North Dakota. Even though the desi chickpea market price is typically substantially less than that for large kabuli types, the increased yield potential and lower production costs might result in equal or greater net returns.

New desi varieties, CDC Anna, CDC Desiray and CDC Nika have been released in Saskatchewan and performance data is limited in Montana and North Dakota (see 2002 Saskatchewan Seed Guide for more information).

Harvesting

Chickpea is sold as a high quality human food product. While seed size is a major factor in economic returns for the kabuli type, seed color is the single most important factor in determining if your crop is marketable. If the seed coats are dark or discolored the crop will NOT be accepted by the food processors. Harvesting decisions such as timing and harvesting methods are the major factors in harvesting seeds with the light yellowish-cream color demanded by the processor.

Factors that affect ripening

Chickpea has an indeterminate growth habit, which means that the growth cycle extends as long as moisture is available. This growth pattern can be problematic in fields with uneven topography where soil water varies strongly throughout the field, or where seeder problems cause uneven emergence.

Herbicide injury, disease and predation by deer also commonly affect maturity by causing uneven field ripening patterns, and sometimes causing green pods to persist until the first fall frost.

Green pods that are frozen or desiccated will remain green and become an important downgrading factor. Less than one-half percent green seeds are allowed for the top commercial grade.[14] Growers should cut around portions of the field with high green seed counts to avoid ruining the whole lot. To maintain a timely harvest for seed quality some producers have combined different parts of the same kabuli chickpea field on three different dates.

Plants are physiologically mature when seeds begin to change color inside the uppermost pods. Producers have the option to direct combine or swath the crop when the pods are straw yellow.

Harvest methods

Chickpea normally has a low shattering potential, although pod drop has occurred in some instances when harvesting was delayed, and pod shattering has occurred in unusually hot late August and early September temperatures.

The lowest pod height is typically four inches above the ground, making direct harvesting possible but requiring an experienced combine operator. In some regions it is advantageous to swath *and* combine, due to fact that delayed harvests can result in darkening of the seed coat.

The desiccant paraquat (Gramoxone Extra) is labeled as a harvest aid for chickpeas, and used mainly to burn down immature weeds which can cause seed staining.

Monitoring of seed color is most important to determine proper harvest timings and management. Chickpea can be harvested at 18% moisture but requires that the crop ripens uniformly, which is rare in this crop.

Minimizing seed damage

Combine speeds, cylinders, sieves and air must be adjusted to prevent seed breakage. Chickpea seeds have a characteristic small protruding beak-like structure that must not be damaged. Seed damage can be minimized by use of conveyor belts or by keeping the standard augers as full as possible and operating at slower speeds.

Storage

Chickpea can be stored at 15% seed moisture. Minimizing the number of times chickpea is handled reduces the frequency of cracked or damaged seed, significant dockage factors. Detailed production information for chickpea growers has been recently published in Canada.[15]

Crop Rotation

Chickpea, like other annual legumes in a rotation, offers several cropping advantages for the producer. Cereal crop yields sometimes increase when planted after legumes, due to the following considerations:

1. Cereal pest cycles have been disrupted.
2. Alternative herbicides to cereal crops can be used to clean up grassy weeds.
3. Soil nitrogen supply is increased.

However, chickpea has a moderately deep rooting system (similar to spring wheat) which is effective at extracting subsoil moisture, and because little stubble remains after harvest to trap snow and minimize evaporation, available crop water can be extremely limited following chickpea.

Fallowing on chickpea stubble presents severe soil erosion risks and should be attempted only if sufficient cereal stubble is present from the year prior to chickpea and if the fallow is managed without tillage.

Chickpea stubble, as is the case for other pulse crop stubbles, should not be used to plant winter wheat because seeding disturbance destroys scarce crop residues and most often there is insufficient soil moisture to properly germinate the winter wheat crop.

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