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Chickpea Production in the High Plains

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Chickpea (*Cicer arietinum* L.) is an annual grain legume or "pulse crop" that is used extensively for human consumption. The seed of this plant, when dried, is commonly used in soup. Its primary use in the United States is for salad bars, while in the Middle East and India it is more frequently cooked and blended with rice dishes. Major chickpea producers include India, Pakistan, Mexico, Turkey, Canada, and Australia. Chickpea makes up more than 20 percent of world pulse production, behind dry bean and pea. Currently, the United States imports more than 80 percent of its domestic chickpea needs.

Since the 1980s, chickpea production has increased rapidly in the northwestern United States. Meanwhile, due to agronomic, processing, and marketing constraints, production in the High Plains has been sporadic and often short-lived. During the past few years, the development of new varieties and the potential for chickpea production under dryland and limited irrigation conditions has generated renewed interest among High Plains producers. With this in mind, the purpose of this publication is to provide information to enhance the potential for successful chickpea production.

Figure 1. Fern leaf structure of chickpea.

Figure 2. Unifoliate leaf structure of chickpea.

Plant Description and Adaptation

Chickpea is an annual cool-season plant that ranges in height from one to three feet. It has an indeterminate and branched growth habit, erect or spreading, with hairy leaves, stems, and seed pods that secrete highly acidic exudates. It typically has a bluish green or dark green color, but some types are olive in appearance. Most chickpea have a fern leaf structure comprised of several pairs of small rounded or oblong leaflets *(Figure 1)*. Some kabuli-type varieties such as Dwelley have a unifoliate leaf structure consisting of a single larger leaf instead of leaflets (*Figure 2*). Chickpea is a self-pollinated crop with flowers that are borne singly at the tip of axillary branches and that vary in color from white to purple to faded blue.

Most of the seed pods develop on the top portion of the plant, usually a minimum of six to eight inches above the soil surface, and are relatively shatter resistant. Seed pods are short and inflated, with commercial types typically having one seed per pod. Each seed is characterized by a median groove around two-thirds of the seed and a "beak" that is formed by the protruding root tip of the exposed embryo.

Chickpea water use will vary, depending on factors such as climatic conditions, soil type, and length of the growing season. As a guideline, chickpea production in the High Plains will require 12-18 inches of water. Chickpea is relatively drought tolerant because it has a long taproot that can extract water from lower depths of the soil profile. Therefore, with the application of 6-10 inches of rainfall and/or irrigation water during the growing season, it is well suited to dryland or limited-irrigation production.

Chickpea performs well when planted on well-drained soils of near neutral pH. It does not tolerate wet, poorly drained, or saline soils. If grown under irrigation, excessive irrigation may promote disease development, leading to crop injury.

Chickpea grows best when daytime temperatures are 70-85°F and nighttime temperatures are near 65°F. Since cotyledons remain below ground, plants can tolerate some late spring frost and will regrow if the top growth is damaged. The time of maturity depends on type and variety and ranges from 95 to 110 days.

Seed Types and Varieties

Chickpea is classified as "kabuli-type" or "desi-type," based primarily on seed size, shape, and color *(Figure 3)*. Collectively, both types of chickpea have been referred to as "garbanzo bean." However, as used in various publications and this production guide, "garbanzo bean" will refer specifically to kabuli-type chickpea.

Kabuli-type chickpea seed is about twice the size of field pea seed and averages about 1000 seeds per pound, with large variation between varieties and environments. The kabuli-type seed has a thin seed coat ranging in color from white (low tannin) to pale cream. Approximately 10 percent of world production is of the large kabuli-type; however, nearly 100 percent of High Plains production is of this type because it has a price premium for the salad bar market.

Desi-type chickpea seed is typically less than one-half the size (2,300 seeds per pound) of the kabuli-type chickpea and has a thicker, irregularly shaped seed coat ranging in color from light tan to black. Natural mutation and selections from desi-type chickpea have resulted in the development of kabuli-type varieties.

Chickpea varieties and experimental lines are being evaluated by the USDA Agricultural Research Service, the New South Wales Department of Agriculture in Australia, and the Crop Development Center in Canada. Commonly planted chickpea varieties in the High Plains include Dwelley, Sanford, and Sierra, all of which are kabuli-type. Variety results are published annually in the Nebraska Extension Circular *Nebraska Seed Guide* (EC-101), University of Wyoming Research and Extension Center Progress Reports, South Dakota State University West River Ag Center Progress Reports, and on the University of Nebraska and University of Wyoming variety evaluation Web sites.

Figure 3. Kabuli-type (left) and desi-type (right) chickpea seed.

Rotational and Cropping System Considerations

Since chickpea is an early season broadleaf, it can be used to add diversity to many cropping systems. Most regional dryland acres are seeded to grass crops; therefore, adding a rotational, broadleaf crop provides an opportunity to break a number of pest life cycles associated with grass crops, including grassy weeds, diseases, and insect pests.

In dryland rotations, chickpea may have a role as a replacement for summer fallow in continuous cropping systems. In this role, chickpea is planted the year following a full-season summer crop, such as corn, and just prior to seeding winter wheat. If there is less than three feet of moist soil at planting, consider summer fallow prior to winter wheat seeding instead. Chickpea is typically harvested in mid-August, allowing two to six weeks for replenishment of surface soil moisture prior to winter wheat seeding. If soil conditions after a chickpea crop remain too dry for winter wheat seeding, growers may consider a dormant winter wheat seeding or planting proso millet the following spring prior to returning to winter wheat. Chickpea is probably not the crop to be grown just prior to an extended fallow season since it does not leave much surface residue to help protect the ground from wind and water erosion.

Although chickpea works well in a rotation with winter wheat and warm-season grasses, such as proso millet and corn, other broadleaf crops in the rotation may be a problem. In order to reduce the risk of sclerotinia (white mold) infection, chickpea should not be rotated in a short cycle with sunflower, dry bean, lentil, pea, or canola, especially under irrigation. In order to help prevent Ascochyta blight, chickpea should not follow any other pulse crop, and shouldn't be planted on the same field more than once in four years.

Water usage by chickpea is greatest from late June through July. It is responsive to limited irrigation but requires much less irrigation than corn or bean to achieve optimum yields. Therefore, it fits limited irrigation cropping systems very well, especially those that are most limited during August when chickpea has low water requirements.

Seedbed Preparation and Planting

Chickpea seed must be placed into a firm moist seedbed. If spring tillage practices are required for seedbed preparation, they should be kept to a minimum and completed as early as possible to conserve soil moisture. Under no-till conditions, avoid excessive amounts of surface residue in order to promote proper seed placement and early warm-up of the soil. Potential production fields must have a history of limited weed pressure since weeds can negatively impact seed yield and are strong competitors with chickpea plants.

Ascochyta blight, the most serious disease threat to chickpea, survives in infected seed and residue. To limit potential disease development, plant only resistant, certified seed purchased from a reputable supplier since it is nearly impossible to certify that chickpea seed is pathogen free.

Although both chickpea types are at increased risk to infection from soil-borne diseases when soils are moist and cold after planting, kabuli-type chickpea is especially prone to seedling infections due to its large seed size and thin seed coat. Poor emergence or none at all is very common if the seed is not treated for these diseases. Maxim 4FS, LSP, Apron XL-XS, and Allegiance are fungicides currently labeled as seed treatments. Before using any seed treatment, always read and follow label directions.

As a legume, chickpea is capable of fixing atmospheric nitrogen for its own use; however, for this to occur, a high quality, specific inoculant (Type GC) must be used. This will ensure that the correct strain of effective rhizobia is available when the seed germinates. Inoculants usually can be purchased in peat (powder) or granular form. Refer to product instructions and consult with a supplier as to application requirements and the form of inoculant that best suits planting practices.

Plant chickpea in April to early May when soil temperature at a depth of 2-3 inches is 45°F and rising. Warm soils are required to promote the rapid germination and emergence of seedlings, thereby reducing the exposure of seedlings to soilborne pathogens. If planted later than mid-May, seed yield and quality can be reduced by frost prior to maturity and by high temperatures during flowering and the early stages of pod fill.

Although chickpea is commonly drilled in row spacings of 7.5-12.0 inches, wider row spacings (22-30 inches) also can be used. Seeding can be accomplished with either conventional planters/drills or air seeders. A planter/drill must be capable of accommodating and uniformly distributing chickpea seed without plugging or causing damage to the seed. Wider row spacings allow for early weed control by cultivation and, as a result of increased air flow between rows, may reduce the incidence of foliar diseases. Even though wider row spacings enhance the loss of soil moisture through surface evaporation, they may be an advantage in drier years by delaying root access to soil moisture stored in the interrow area, conserving it for later use during flowering and pod fill. However, if precipitation and/or irrigation water is plentiful, narrower row spacings may enhance the use of interrow nutrients and water. In general, wider row spacings will increase the likelihood of late-season weed problems and delay maturity while narrower row spacings will enhance crop uniformity and crop-suppression weed control.

Chickpea seeds require a large amount of water to germinate. This necessitates good seed-to-soil contact and a seeding depth of 1 inch below soil moisture for desi-type and up to 2 inches below soil moisture for kabuli-type chickpea. Seedling emergence can be significantly reduced at seeding depths greater than 3 inches. Seedlings will not survive if the soil is allowed to dry out below the germinating seed.

Seeding rates for chickpea will vary with germination percentage, seed size, and the availability of soil moisture. Ultimately, a seeding rate should target a plant density of about 3-4 plants per square foot. This seeding rate equates to approximately 100-140 and 80-95 pounds of seed per acre for kabuli-type and desi-type chickpea, respectively.

Fertility

Fertility requirements for chickpea production in the High Plains are based on limited research data and are not well defined. Based on available information, guidelines have been established for nitrogen, phosphorus, and sulfur fertilization.

If properly inoculated, chickpea will fix its own nitrogen. Additional nitrogen fertilizer (20-30 pounds nitrogen per acre) is recommended if soil residual NO_3-N is less than 20 pounds per acre in the top foot of soil. Research indicates that small amounts of nitrogen (i.e., 20 pounds per acre of 10-50-0 or 11-52-0) can be safely placed with the seed. However, it is recommended that nitrogen be band applied (2 inches below or to the side of seed placement) or broadcast applied. Excessive amounts of nitrogen can reduce nitrogen fixation and delay maturity.

Phosphorus is required for chickpea development and nitrogen fixation. Since it is often a limiting nutrient in the High Plains, especially on calcareous soils, soil testing is essential for determining residual levels of soil phosphorus. If residual levels of soil phosphorus are below 5-10 parts per million (sodium bicarbonate test), P_2O_5 should be broadcast or band applied at the rate of 40 and 20 pounds per acre, respectively.

Chickpea is also thought to respond to sulfur applications on sandy soils low in organic matter; however, if sulfur has been applied to other crops (10-15 pounds sulfur per acre) in rotation with chickpeas, it is likely that crop response, if any, will be minimal.

Weed Control

Weeds can have a major impact on chickpea seed yield and quality. Weeds that grow above the crop canopy will cause greater seed yield loss than weeds that remain below the canopy. For example, common sunflower will cause more crop competition than green foxtail. Time of weed emergence has a significant impact on weed competitiveness; weeds emerging with the crop cause greater yield losses than weeds emerging later in the growing season. To prevent crop losses, chickpea needs to be kept free of weeds until the canopy begins to cover the soil surface.

Several factors should be considered when planning a weed management program for chickpea. Factors such as expected weed species, cover crop, preplant tillage, herbicide incorporation, crop rotation, crop cultivar, row spacing, cultivation, and herbicides all need to be integrated to develop an effective weed control strategy.

Accurate weed identification should be the first step in any weed management program and is important in the selection of a herbicide. The use of a fall-planted cover crop can reduce weed emergence the following spring. The cover crop can be killed with glyphosate and then chickpea planted directly into it. Because spring tillage is reduced, summer annual weed populations will be lower. Late-season weed density increases as row spacing increases. Chickpea planted in 30-inch rows will have more late-season weed problems than crops drilled in narrow rows.

Herbicide performance has generally been best when herbicides are applied before or after planting but before weed emergence. Herbicide selection will depend on expected weed species, chemical expense, and whether the herbicide is incorporated before planting.

Chickpea is susceptible to several persistent herbicides used in corn and wheat production, including Ally, Amber, atrazine, Curtail, and Stinger. Care should be taken with herbicide selection and use in crops preceding chickpea in cropping rotations. Consult the University of Nebraska *Guide for Weed Management* (EC-130) or South Dakota State University *Weed Control in Pulse Crops* (FS 525-PC) for a complete list of herbicides labeled for use on chickpea.

Diseases

Although chickpea is susceptible to a large number of diseases (more than 50 have been reported worldwide), few have a significant impact on production. The two most important diseases include Ascochyta blight, caused by *Ascochyta rabiei,* and Fusarium wilt, caused by *F. oxysporum* f. sp. *ciceris.*

Both of these diseases have recently been identified in Nebraska, but Ascochyta blight is the disease of major concern (*Figure 4*). Regional climatic conditions generally do not favor the development of either disease, but under the right conditions of high humidity, plentiful soil moisture, and moderate temperatures (75-80^{o}F), either could become a problem. These diseases are limited to chickpea and do not infect other legume crops such as dry bean. Tolerant cultivars are available for both diseases, but generally these will not be sufficient if an epidemic of Ascochyta blight occurs. Several fungicides are labeled for this disease and should be used in conjunction with genetic resistance, timely scouting, and fungicidal seed treatments.

Figure 4. Chickpea pods infected with Ascochyta blight.

Several other diseases also have been identified in Nebraska chickpea production in recent years, but they are likely of minor importance. These include a number of root rot and collar rots caused by *Fusarium solani*, *Rhizoctonia*, and *Phytophthora* spp. The *Fusarium solani* and *Rhizoctonia* have been observed more commonly in dryland production. Under sprinkler irrigation, Fusarium wilt has been observed as well as a foot rot caused by Phytophthora. Currently, the only concern that these soilborne pathogens represent is their potential for causing disease on other rotational crops in the region such as dry bean (*F. solani* and *Rhizoctonia*) and alfalfa (*Phytophthora*). Control measures at this time do not appear warranted.

Insects

Insect problems have been limited in High Plains chickpea production; however, the potential exists for some insects to cause damage. As a result, continued monitoring of chickpea will be needed to determine the true risk potential associated with regional insects and insect damage. Insects common to the region that are reported to feed on chickpea include leafminers, early-season and late-season cutworms, aphids, grasshoppers, and corn earworm.

The only noticeable insect problem has been extensive infestations of a species of Agromyzid leafminer feeding on dryland chickpea. The adult of this insect is a small fly that, along with its maggot-like larvae, feeds under the leaf surface, creating wandering mines on the leaf. Although numerous mines have been observed on leaves, the impact of this damage is not known. Control options, if even necessary, are not understood and would be difficult to determine.

Early season cutworms (army cutworm, pale western cutworm) could be a problem if chickpea is planted into a winter cereal cover crop or around field margins because these insects can move out from neighboring grasslands into chickpea fields. The western bean cutworm may be a late-season problem, but the extent to which this insect will feed on chickpea is unknown.

Pea aphid is commonly found on alfalfa in the region and will feed on chickpea. Normally, this insect is not overly damaging; however, if populations build at flowering or shortly thereafter, seed yields can be significantly reduced.

Grasshoppers often seek plants with good nutrition and chickpea, being a legume with a high nitrogen content, would likely be a preferred target. In years when grasshoppers are at high levels, it is important to watch infestations around chickpea fields.

Since corn earworms do not overwinter in this region, their potential damage to chickpea is not as serious as has been reported in other areas. However, corn earworms do migrate into the region later in the season and could develop into a problem after mid-season.

Harvesting

The timing of harvest becomes a balance of seed yield and quality. Although seed size is an important factor affecting gross return per acre, seed quality, which is primarily a function of seed color, is the major factor in determining the marketability of a chickpea crop. Large, uniform, undamaged, light-colored seeds are favored by the market. Any dark brown, green, or black seeds will reduce the value of the seed.

Plants are physiologically mature when the leaves have dropped and the pods turn a tan or cream color (*Figure 5*). Seed color, which is the most important criteria for proper harvest timing and management, should have turned from green to tan. Due to the indeterminate plant growth of chickpea, differences in pod size and maturity will occur at harvest. Although chickpea pods resist shattering, delaying harvest beyond maturity can result in broken pod stems and dropped pods.

Chickpea can be combined directly or swathed prior to combining. Direct combining, which is the most common harvest practice, allows additional time for plant development, resulting in potential increases in seed yield. On the other hand, swathing and combining allows for more uniformity in crop drying, seed color, and size. Desiccants have been tried to improve crop dry down and uniformity prior to direct combining, but they have the potential to reduce seed size and cause pod drop. Both types of harvest are improved by no-till planting into cereal stubble, a practice that increases the height of the chickpea plant due to reduced light intensity during early seedling development.

It is very important that "green" or unevenly mature areas of a field be avoided and allowed to ripen before combining. Ideally, for standing harvest, seed moisture should range from 15 to 18 percent. Although seeds may be less uniform within this range, mechanical damage will be lower. At a seed moisture content below approximately 13 percent, pod shattering and seed cracking can seriously affect harvest loss and seed quality. Swathing of the crop is usually initiated at 25 to 30 percent seed moisture.

Continuous monitoring for cracked seed and damaged seed coats is necessary to ensure that the combine is

Figure 5. Mature chickpea plants.

properly adjusted. Depending on the type of chickpea, general guidelines for combine settings include:

1) a reel speed equivalent to ground speed (less than 5 miles per hour);
2) a cylinder speed of 400-600 revolutions per minute;
3) a concave setting of 0.4-1.2 inches;
4) high air flow;
5) a top sieve setting of 0.8-1.0 inch; and
6) a bottom sieve setting of 0.5-0.6 inch.

Cracking is minimized by using conveyor belts or operating at slower speeds and keeping augers as full as possible.

After harvest, careful handling of chickpea seed is also an important consideration. Often quality is lost when removing chickpea from storage. Alternative seed handling equipment, such as brush augers or belt conveyors, should be considered. Seed at 14 percent moisture content should be safe for storage; however, in-bin temperatures need to be monitored, especially as outside temperatures fluctuate. If necessary, aeration can be used to cool and dry the seed.

Markets and Economics

The domestic consumption of dry pea, lentil, and chickpea has increased from less than 0.5 pound to more than one pound per person since the early 1980s. In addition, the export markets for chickpea have increased in several countries, including India, Canada, and the European Union (most notably Spain).

Virtually all domestic pulse crop production is marketed through processors, with about 20 percent of the production contracted and the majority (80 percent) sold on the spot market. Conditions in major foreign markets, including Canada, Mexico, and Turkey, influence the pricing of chickpea. On a global basis, the relatively low production of chickpea in the United States limits the ability of domestic producers to influence world markets and to consistently produce sufficient quantities to be a reliable supplier for large users.

The 2002 Farm Bill included a marketing loan program that will serve as a price support mechanism for domestic chickpea production. This program should help stabilize producer revenues and develop new uses and markets. However, the program loan rate of $7.56 per hundredweight is only applicable for desi-type chickpea small enough to fall through a 20/64 (0.31 inch) screen.

A key to developing a viable, regional chickpea industry is finding secondary markets for chickpea that fail to meet human food grades. While much lower priced as livestock feed, chickpea can play a role in livestock rations as a substitute for higher cost protein sources.

Using a full-costing method (including costs for inputs, machinery use, labor, management, and land), it is estimated that the cash input cost for the production of dryland chickpea can exceed $100 per acre, with a total economic cost of $185 per acre. For the production of irrigated chickpea, it is estimated that the cash input cost can exceed $150 per acre, with a total economic cost of $313 per acre.

In recent years, the pricing of chickpea has been calculated according to a three-tiered pricing schedule based on seed size. The price schedule and expectations are presented in *Table I*. In reference to *Table I*, it should be noted that the current marketing loan program would only affect this pricing schedule at the smallest seed size. The U.S. Department of Agriculture grades all chickpeas for splits, color, size, and foreign material. In addition, based on expected end use, the industry may have specific standards by which the crop is sorted.

Table I. Sample price schedule for western Nebraska chickpea growers.

Seed Size	*Large >0.35 in*	*Medium 0.31-0.35 in*	*Small <0.31 in*
Price ($/cwt)	$17.00	$12.00	$6.00
Expected Percent of Crop *(dryland)*	60-70%	20-30%	5-15%
Expected Percent of Crop *(irrigated)*	85-95%	3-10%	2-5%

Tables II and *III* show costs and returns for chickpea produced in irrigated and dryland cropping systems. For different seed yields, revenues presented in these tables are based on a three-tiered pricing schedule (see *Table I*) and a contract price of $17.00 per hundredweight for large kabuli-type chickpea. At a given contract price, data in *Tables II* and *III* indicate that net returns can be dramatically affected by even small reductions in seed yield. Therefore, it is important to note that, although large variations in chickpea seed yield can occur from year to year, seed yields would be expected to average 1,300 and 2,200 pounds per acre in dryland and irrigated cropping systems, respectively. In addition to seed yield reductions, there are also potential losses associated with reduced seed size that are not quantified in these tables.

Table II. Cost and return for dryland chickpea at different seed yields.

	Dryland Chickpea Seed Yield (lbs/acre)				
Seed Price ($/cwt)	*1800*	*1500*	*1200*	*900*	*600*
(Large 65%) 17.00	198.90	165.75	132.60	99.45	66.30
(Medium 25%) 12.00	54.00	45.00	36.00	27.00	18.00
(Small 10%) 6.00	10.80	9.00	7.20	5.40	3.60
Total Revenue	$263.70	$219.75	$175.80	$131.85	$87.90
(-) Total Cost	$184.28	$184.28	$184.28	$184.28	$184.28
(=) Net Return	$79.42	$35.47	($8.48)	($52.43)	($96.38)

Table III. Cost and return for irrigated chickpea at different seed yields.

	Irrigated Chickpea Seed Yield (lbs/acre)				
Seed Price ($/cwt)	*2400*	*2100*	*1800*	*1500*	*1200*
(Large 85%) 17.00	346.80	303.45	260.10	216.75	173.40
(Med. 10%) 12.00	28.80	25.20	21.60	18.00	14.40
(Small 5%) 6.00	7.20	6.30	5.40	4.50	3.60
Total Revenue	$382.80	$334.95	$287.10	$239.25	$191.40
(-) Total Cost	$312.93	$312.93	$312.93	$312.93	$312.93
(=) Net Return	$69.87	$22.02	($25.83)	($73.68)	$121.53)

The economic viability of a specialty crop such as chickpea will ultimately depend on several factors, including market development, contract and seed pricing, pesticide availability, and production capability. Producers are cautioned to be aware of the potential impact of all such factors before attempting large-scale production.