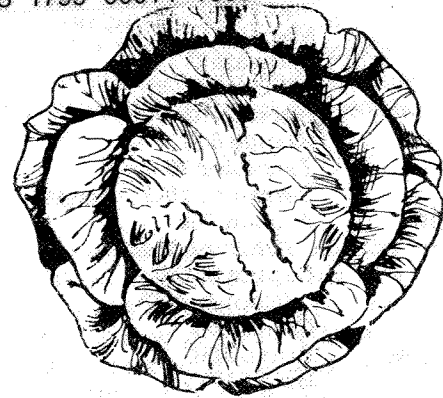


Commercial vegetable production: cabbage

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Quick Facts

The type of cabbage most commonly grown in Colorado is standard, market, green, round, and early or mid-season. Hybrid cabbage usually outyields standard types but seed may be 10 times as expensive. Transplanting can only be justified when growing for an early summer market. To obtain a successful crop by direct seeding, it is necessary to have control over weeds, crust, insects and disease. When heads become hard and the outer wrapper leaf begins to curl back at the edge, the head is ready to harvest.

Cabbage is grown in all irrigated valleys of Colorado with most of the state's 2000 A grown north of the Denver area, along the South Platte River. All of the crop is sold on the fresh market.

Terms used to describe cabbage are hybrid or standard; market or sauerkraut; red or green; pointed, round or flat; early, mid-season or late; and regular or chinese. The cabbage types most commonly produced in Colorado are: standard, market, green, round, and early or mid-season. Varieties of this type are Glory of Enkhuizen, Marion Market, Golden Acre yr, Bonanza, and Globe yr.

Hybrids can be used by experienced growers who have successfully obtained stands with direct seeding or growers who transplant. While hybrids usually produce more uniform stands and therefore, greater yields with fewer cuttings, the seed costs up to 10 times more than standard seed. This may not be cost effective especially if a field has to be re-seeded. Early hybrid for trial are Jetpack, Solid Blue 690 and Stone Head. Moneymaker and Supermarket are mid-season and Hercules and Rio Verde are late cabbage.

Transplanting

Transplanting can only be justified when growing for an early summer market since direct field seeding is more economical for late summer and fall markets.

The method chosen to produce transplants will depend on the number of transplants needed and whether transplant production is going to be a perennial operation.

For small operations it could prove most cost effective to contract out the plant production, allowing six weeks from seeding to field planting.

A protective structure will be required if transplants are to be grown in cold weather. Seed may be sown directly in ground beds, in cellular containers or in flats. The system used will dictate the seeding method used. When grown in ground beds the plants will go to the field as bare root

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transplants. When seeded in flats, they will be transplanted into pots or cells, then grown out for four weeks before going to the field.

It requires six weeks to produce a transplant. They should be germinated at 75° F, then grown at a night temperature of 55° for five weeks. During the final week, the night temperature should be held to just above freezing in order to harden the plants. During the growing period they should be fertilized with 1 oz. of 10-52-17 fertilizer per gallon three times a week. If cold temperatures are not available during the sixth week, water should be withheld to the point where they are slightly wilted most of the time.

It is a good idea to pre-irrigate the field then supply each plant with 0.5 pint of water containing 2 pounds of 10-52-17 per 50 gallons. Transplanting should begin after 12 N to avoid excess wilting. Bare-rooted plants should only be used in cool weather. Irrigation should follow as soon after transplanting as practical.

Field Preparation

A good seed bed is desirable for transplanting and absolutely necessary for direct field seeding if seeds are to be planted at a uniform depth and properly covered with loose soil. The surest way to obtain a good seed bed on clay dominated Colorado soils is to fall plow, mulch, and list up rough beds to be mellowed by frost action during the winter. Just before planting, the beds are formed with a bed shaper or smoothed with tillage tools to eliminate weeds and give a firm smooth seed bed for either direct seeding or transplanting.

Fertilizer

The fertility status of the soil should be determined from a composite soil sample taken from the top 8 inches of the field. The nutrients needed are recommended as part of the soil report. If not tested, the soil should receive 100 pounds of nitrogen and 100 pounds of phosphoric acid (P_2O_5) per acre with another 50 pounds of nitrogen applied just before the crop starts to head.

Fertilizer may be broadcast over the field after plowing and before mulching or disking, or it may be shanked into the bed at or just before seeding or transplanting. The fertilizer band should be placed 2 inches to the side and 2 inches below the seed or transplant. Burning will result if it is placed in contact with the seed or transplant, and if it is shanked too far away from the row, it will not provide early benefits.

Direct Field Seeding

To obtain a successful crop by direct seeding, it is necessary to have control over weeds, crust, insects and disease. The field should not have had cabbage or related crops in it for four years. If nematodes or diseases are known to be present, fumigation should be considered. Chemical weed control and seed protection are standard measures when direct seeding.

The seed should be planted $\frac{3}{4}$ inch deep, 2 to 6 inches apart in single rows 30 inches apart or twin

rows 14 inches apart on 40-inch beds. The amount of seed sown per acre reflects the grower's confidence in being able to obtain a stand.

Irrigation may be necessary to initiate germination. If a crust develops over the row it will be necessary to roll the beds with a cultipacker or irrigate to loosen seedlings caught in the crust.

As soon as the seedlings emerge, they should be observed for flea beetle damage and protected if flea beetles are found. When the tractor operator can see the rows, seedlings should be cultivated. The first cultivation usually uses a disk on either side of the row to cut the crust and trash, and thereby prevent the seedlings from being uprooted by any shifting of the crust during cultivation. The disks are followed by knives which undercut weeds in their path, and then duck feet which eliminate weeds between the rows. Ditches then follow to re-make the furrows.

The disks are removed after the first cultivation and knives are moved further apart with each subsequent cultivation to avoid damaging the crop.

As soon as the cabbage plants begin to crowd, they should be hoed and thinned, leaving a plant every 6 inches. When they begin to crowd they are thinned to the final stand which may be 12 to 24 inches, depending on the variety.

Herbicides

Treflan (trifluralin) is applied pre-plant at 0.5 to 1.0 pounds of active material per acre and incorporated. Dacthal (DCPA) is applied pre-emergence at 10 pounds of active material per acre. Both may also be used with transplants. The label should be read especially in regard to soil types, cole crops have shown marginal tolerance to Treflan at recommended rates.

Insect Control

Flea beetles may infest and seriously damage the crop during seedling stages. Vigorously growing plants can often outgrow flea beetle injury but severe infestations need control. Applications of insecticides rarely persist longer than five to seven days on growing foliage. Edges of fields bordering permanent vegetation are usually most seriously damaged.

Aphids, primarily cabbage aphid and turnip aphid, can infest new growth; this injury may need control if infestations are heavy enough to threaten distortion of growth. As harvest approaches an insecticide with aphid control should be applied to prevent contamination of the marketed heads.

Later, protection against cabbage looper, imported cabbage worm and diamond-back moth will be required. Damage done by these insects prior to head formation has little effect on yield. After head formation, control is very important to prevent product contamination by insects.

Use of a wetting agent is often desirable when making applications to improve coverage of waxy leaves.

Cabbage worm control should begin after head formation. Most caterpillars do not pene-

trate wrapper leaves until the insects are nearly full grown. Consequently, applications at intervals of less than one week are not necessary if coverage is effective.

Diseases

Alternaria leaf spot (caused by *Alternaria brassicae*) causes yellow, concentric spots on foliage which may turn brown and die.

Black rot (caused by *Xanthomonas campestris* pv. *campestris*) produces yellow, angular spots which progress inward from the leaf margin. Leaf veins become dark brown to black, and heads may be deformed.

Club root (caused by *Plasmodiophora brassicae*) causes plant yellowing and wilting, with large spindle-shaped galls on roots.

Damping off and seedling blight (caused by *Pythium*, *Rhizoctonia* and *Fusarium* species) causes a pre- or postemergence wilting and death of seedlings. Roots and hypocotyls are discolored, water-soaked and/or rotted.

Downy mildew (caused by *Peronospora parasitica*) produces yellow spots on the upper surface with bluish to white fungal growth on the lower surface of leaves.

Nematodes cause poor root development, root galls, root cysts, and/or stunted and yellow plants.

When a field becomes infested with nematodes fumigation is required before planting a cabbage crop. At present, the added cost of fumigation makes production of cabbage prohibitive on such a field.

Wirestem (caused by *Rhizoctonia solani*) produces a darkened and girdled stem at the soil line. Plants are stunted and a leaf rot is often present near the soil.

Cabbage yellows (caused by *Fusarium oxysporum* f. *conglutinans*) affects cabbage plants at any age. The first sign is lifeless yellow-green color of the foliage followed by death. The only practical means of control is resistant varieties.

Harvesting

When heads become hard and the outer wrapper leaf begins to curl back at the edge, the head is ready to harvest. At this stage, it will not increase in size, and further growth will result in splitting. Hybrids are more uniform and usually require no more than two cuttings, while standard varieties are usually cut more than twice and seldom equal the yield of hybrids. Transplanting promotes uniformity; however, only hybrids are generally transplanted because it pays to use the best seed with such an expensive operation.

Table 1: Insecticide recommendations.

Insect	Insecticide	Rate (lb actual/A)	Days to harvest	Remarks	
Flea-Beetle	carbaryl (Sevin, Savit, Sevimol, etc.)	1.0	3		
	endosulfan (Thiodan, Tiovel)	0.75-1.0	7		
	Methoxychlor	1.0-2.0	14		
	Disyston	As labelled	42	Restricted use. Planting treatments do not allow granules to contact seed.	
Cabbage Looper, Imported Cabbage-worm, Diamond-back Moth and other worms	<i>Bacillus thuringiensis</i> (Dipel, Javelin, Thuricide)	As labelled	0	Microbial insecticide, stops feeding within hours, dies in 2-3 days	
	permethrin (Ambush, Pounce)	0.05-0.2	1	Restricted	
	mevinphos (Phosdrin)	0.25-1.0	1-3	Restricted	
	Pydrin	0.05-0.2	3	Restricted	
	methomyl (Lannate, Nudrin)	0.25-1.0	3	Restricted	
	endosulfan (Thiodan, Tiovel)	0.75-1.0	7		
	Guthion	0.5-0.35	21	Restricted	
	Monitor	0.5-1.0	35	Restricted	
	Aphid	mevinphos (Phosdrin)	0.25-1.0	1-3	Restricted
		malathion	0.4-0.8	3	
diazinon		0.25-0.5	7		
endosulfan (Thiodan, Tiovel)		0.75-1.0	7		
dimethoate (Cygon)		0.25-0.5	7		
Metasystox-R		0.75-1.0	7		
Guthion		0.5-0.75	21	Restricted	
Monitor	0.5-1.0	14-21	Restricted		

Table 2: Disease control recommendations.

Disease	Pesticide	Rate (Acre)	Application frequency (days)	Days before harvest
Alternaria	Bravo 500	2.25 pt	7-10	
	Dithane FZ	1.2-2 qt	3-5	7
	Dithane Z 78	4-6 lb	7-14	7
	Dithane M22 Sp	1.5 lb	3-10	7
	Kocide Maneb	1.2-1.6 qt	3-5	7
	Kocide 101, 606	2 lb, 2.6 pt	7-10	
	Maneb 80	2.25 lb	3-5	7
	Maneb FL	1.3-1.6 qt	5-7	7
	Manzate D	2.25 lb	3-10	7
Black Rot	Cit Cop 5E	1.5 pt	7-10	
	Kocide 101	2 lb	7-10	
	Kocide 606	2.6 pt	7-10	
Club Root	Terraclor 75	2-6 lb/100 gal	At planting	
	Terraclor 10G	200 lb/13,100 ft	Before planting	
Damping Off	Arasan 70s	5.3 oz/100 lb	Seed treatment	
	(Thiram 42s)			
	Captan 30DD (Captan 400)	1.2-2 fl oz/100 lb	Seed treatment	
Downy Mildew	Captan 50	15 lb	Preplant, broadcast	
	Bravo 500	2.25 pt	7-10	
	Bravo W75	1.5 lb	7-10	
	Cit Cop 5E	1.5 pt	7-10	
	Dithane Z78	4-6 lb	7-14	7
	Dithane FZ	1.2-2 qt	3-5	7
	Dithane M22 Sp	1.5 lb	3-10	7
	Kocide Maneb	1.2-1.6 qt	3-5	7
	Kocide 101	0.5-1 lb	7	
	Kocide 606	0.6-1.3 pt	7	
	Maneb 80	2.25 lb	3-5	7
	Maneb FL	1.3-1.6 qt	5-7	7
	Manzate D	2.25 lb	3-10	7
	Top Cop & S	2 qt	7-10	
Nematodes	Nemacur 15G	26.7-40 lb	At planting	
	Telone II	9-15 gal	Preplant, aerate 7-14 days	
	Telone C-17	10-17 gal	Preplant, aerate 7-14 days	
	Vapam	40-100 gal	Preplant, aerate 7-14 days	
	Vorlex	7-15 gal	Preplant, aerate 14 days	
Wirestem	Terraclor 75	10-20 lb in 35-50 gal per 13,100 ft	Broadcast or row drench at seeding	