BROCCOLI PRODUCTION

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Broccoli is a cool season crop, closely related to cabbage, cauliflower, kale, and mustard. It can be grown as either a spring or a fall crop. Broccoli is a high quality vegetable for fresh use and is one of the more popular frozen vegetables. Broccoli is highly nutritious, and has been deemed an anticancerous food by the American Cancer Society. They are a good source of Vitamin A, calcium and riboflavin or Vitamin B2. The edible portion of the broccoli plant consists of the tender stem and the unopened flower buds. Sprouting broccoli should not be confused with broccoli-raab (or Italian turnip) which is grown for early leafy greens and with much smaller flower shoots.

TRANSPLANT PRODUCTION. Plants may be started in hotbeds or greenhouses. In a hotbed the seedlings need a loose, easily pulverized loam that is not too fertile. If the plants are started in hotbeds, soil fumigation is needed to control weeds, soil borne diseases, and insects. Check Plant Pathology Note 170, Soil Treatments for Greenhouse and Plant Beds-Vegetable and Ornamentals. Plant the seeds one-quarter to one-half inch deep in rows 4-6 inches apart with 2-4 seeds per inch. Thin the seedlings at the two-leaf stage; allow 1-1/2 inches between plants. Water twice daily and fertilize with soluble fertilizer at least every 2 weeks. Proper ventilation is important and can be maintained by raising the sash or plastic covering during the hottest portion of the day. In the hotbed, if properly handled, 3 or 4 ounces of seed will produce enough seedlings to plant 1 acre. When seed is planted in beds, it requires about 6 to 8 weeks from seed to plants for the spring crop, and about 4 to 5

weeks for the fall crop. In the greenhouse a variety of plant growing containers may be used (i.e. plastic cell paks, peat pots, and speedling trays). These containers should be filled with an artificial media, usually a combination of peat, perlite, vermiculite, and in some instances bark. The seeds can be sown directly into the containers and thinned upon emergence to 1 plant per cell or pot. In the greenhouse it will require 5 to 6 weeks from seed to plants for the spring crop and 4 to 5 weeks for the fall crop. Note: See extension publication AG-337, Production of Commercial Vegetable Transplants, for detailed information on plant production.

The fall crop of broccoli can also be direct seeded in the field using a precision planter such as a Stanhay, Gaspardo, or Nibex. Seed required for one acre is 0.75 to 1.25 pounds when using a precision seeder.

SOILS. Soils that are well suited for the production of broccoli are fertile, well drained, and have texture ranging from sandy loam to clay loam. Soil pH should be 6.0 to 6.5. Lime according to soil test recommendation. Organic soil does not require such a high pH.

Spring crop Time to Plant

	Sow Seed in Frames	Sow Seed in Greenhouse	Set in Field	Direct Field Seeding
Coastal Plain	Dec.-Jan.	mid-Jan.	late Feb.	mid Feb.
Piedmont	Jan.-Feb.	Feb.	mid March	early

				March
Mountains	Feb.-July	March-July	early April to early Aug.	mid March to early Aug.

Transplanting is preferred for the spring crop since it results in a more uniform stand and earlier harvest.

Fall crop	Time to Plant		
	Sow Seed in Fields or Bed	Set in Field	Direct Seeding in Field
Coastal Plain	early July	Aug.	Aug. to mid Sept.
Piedmont	early July	Aug. 1-10	mid July to mid Aug.

Irrigation will be essential when transplanting the fall crop.

FERTILIZER. Take a soil test and fertilize according to the soil test recommendations. A general recommendation would be 85 to 120 lbs of nitrogen, 170-240 lbs P_2O_5 and 170-240 lbs K_2O_5, plus 15-20 lbs of borax per acre. Without boron, small buds, hollow pithy stems with internal brown discoloration and low yields can result. Sidedress after 3 and 5 weeks with 30 lbs of actual nitrogen per acre. Home gardeners should mix 2 level tablespoons of borax to 5 qts. of fertilizer and apply this to each 100 ft. of row before planting. Apply 100 pounds per acre of calcium nitrate when heads are about the size of a quarter. This will

reduce large stem diameter and to some extent rots. Distance between leaves should be 3/4 to 1 inch to indicate rapid growth, if not, apply more nitrogen.

WEED MANAGEMENT.* Consult the current N.C. Agricultural Chemicals Manual or your local county extension center for weed management recommendations. Cultivation is often necessary.

TRANSPLANTING. Plant on medium-ridged (8-10 inches tall) rows 36 to 42 inches apart with 2 rows per bed (9 to 12 inches apart) and 4 to 6 inches between plants in the row. This requires between 43,560 and 29,869 plants per acre. Mechanical trans-planters, hand transplanters or hand trowels may be used. Double rows will require that mechanical transplanters be set up in tandem or offset, and the field driven twice. To insure proper settling of soil around the roots, water the plants well. Use about 1/2 pint of starter solution (5 pounds of 5-20-10 or 12-48-8 fertilizer per 100 gallons of water) on each transplant, or use commercially prepared starter solution according to manufacturer's instructions. This will produce heads and stalks of acceptable quality for the bunching/shipping trade. Home garden, local sale, and large single head crops should be spaced further apart for larger head size.

DIRECT SEEDING. Row spacings are similar to transplanting but in-row spacing should be reduced to 4 to 6 inches. Always use a precision seeder like a Gaspardo, StanHay or Nibex (Earthway Planters can be used by small growers). Seed 1/2 to 3/4 inches deep and irrigate frequently to keep surface moist until plants are established. Monitor insects closely during this time.

IRRIGATION. Be prepared to irrigate 1 to 1 1/2 inches of water per week if natural rainfall is lacking to help ensure a high quality broccoli crop. Broccoli requires above average moisture and when this is lacking it responds with slow growth and poor appearance.

INSECT MANAGEMENT.* Several species of caterpillars attack broccoli. Cabbage loopers, the imported cabbage worm, the diamondback moth, the cabbage webworm and the corn earworm are commonly found feeding on leaves and stems. The cabbage aphid is also a very destructive pest on broccoli. Flea beetles also attack broccoli and can severely damage small seedlings. The severity of insect attack is much greater in fall crops. It is suggested that the control program start early (emerging seedlings) and continued on a regular basis. Consult Entomology Insect Note No. 12, Cabbage Worm Complex.

DISEASE MANAGEMENT.*. Diseases are not usually serious to broccoli. The exceptions are such diseases as black rot which may spread from cabbage or related crops or weeds, and may also be carried on seeds. Powdery and downy mildew are often found but only rarely are they a serious problem. Alternaria leaf spot may also be found on broccoli. Soft rot can be serious in years of high precipitation; domed heads with certain varieties will help reduce this disease.

HARVESTING. Spring broccoli should be harvested in the early morning since it wilts very rapidly in the sun. Field crates or baskets should be immediately removed to a packing shelter where it is bunched and iced. The broccoli head should be cut before

the flower buds open. If the buds begin to open and the yellow flower petals begin to show, the head is over-mature and unfit for market. Cut the heads with a length of 9 to 10 inches from the base of the stem to the top of the head. The central heads vary from 3 to 6 inches in diameter. A few days after the central head is cut, small lateral or side shoots grow out and produce small heads measuring 1 to 3 inches in diameter. These side shoots are seldom of the quality for commercial sale. Small heads produced by the side shoots are very desirable for freezing and use in the home. In order to harvest at the correct stage, the field should be cut every 2 or 3 days. It requires 4 to 5 man hours per acre for each cutting. An average commercial field is cut 4 to 6 times; for home use the number of harvests are more numerous since more of the small side shoots can be utilized. Light frosts do not hurt broccoli appreciably, therefore, harvest in the fall generally continues until the first freeze.
Field packing is becoming more popular with the advent of in package icing. Here, broccoli is cut and packed on a harvest aid directly in the field. The boxes are palletized and taken to a central icing facility.

PREPARATION FOR MARKET. A good job of grading, trimming and bunching is needed to compete with western broccoli. Stems are usually trimmed to 6 1/2 to 8 inches in length, leaves are removed and enough heads included to make 1 1/4 to 1 1/2 pounds per bunch. The heads are tied or held together with either tape, rubber bands or paper-covered wires, called "twist-ems". It is important to make the bunch tight. Broccoli can be packed in crates and hampers although wax-impregnated cartons are preferred. A standard carton contains 14 to 18 bunches with a net weight of 21 to 23 pounds. Since broccoli is a highly perishable commodity, subject to rapid color and quality deterioration, it should be precooled to about 32 F by vacuum cooling, hydrocooling

or packing in ice as soon as possible after harvest. For medium to long distance shipping refrigerated transportation and package icing is absolutely essential. Slush ice (40% ice and 60% water) is forced into each box by a special machine. This is a very efficient system and yields a top quality product. Machines exist to ice whole pallets full of boxes at one time. Approximately 5 to 8 pounds of crushed ice should be placed in each carton before shipping.

YIELD. Central heads will vary in size, depending on variety, spacing and growing conditions. The central head weights will range from 0.3 to 1.0 pound each, while side shoots will average between 0.1 to 0.3 pound. The commercial trade only accepts 2 to 5 heads in a 1.25 to 1.5 pound bunch. Under good management and good growing conditions, per-acre yields should average between 400 to 500 cartons (21 pounds net).

VARIETIES. Varieties that have proved reliable in recent variety tests are listed below:

Baccus - early
Green Comet - early - home garden/ pick-your-own
Early Dawn - early
Galleon - early
Packman - early
Emperor - midseason
Legend - midseason
Mariner - midseason
Premium Crop - midseason
Green Duke - midseason
Arcadia - late
Green Valiant - late

Green Defender - late
Southern Comet - single head

* Refer to the N.C. Agricultural Chemicals Manual for additional information.

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BROCCOLI RAAB

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Broccoli-raab (also known as rapa, rapine, rappone, fall and spring raab or turnip broccoli) is a rapidly growing annual when grown in spring, but a biennial in fall plantings. The leaves with the seedstalks, before blooming, are cut for greens and are sold to ethnic markets (primarily Italian).

It is grown for two purposes: 1) for greens, and 2) for greens plus the unopened flower buds and stems.

There are several varieties of broccoli-raab. In general, there are two types, namely: "Broccoli-raab Fall" and "Broccoli-raab Spring". They are essentially the same except that the fall strains tend to form flower heads a little earlier than the spring varieties. There is generally very little difference between the two. Some of the fall strains will overwinter better than the spring varieties.

Some of the varieties listed are Annual (Fina 2), Rappone, Rapa, Fall and Spring raab.

SOILS

This crop may be grown in a variety of soils. The heavier loams will generally produce the greatest yields but for early spring growth and overwintering in the east, a lighter, well-drained, sandy loam is best. Soils should be well drained, high in organic matter and well prepared. A pH of 6.0 to 6.5 is desirable.

FERTILIZERS

Leafy vegetables require quick, continuous growth for best quality. They need nitrogen especially for good color and tenderness. For the average soils use 800 pounds of an 8-8-8 fertilizer per acre before planting. Sidedress with 15-20 pounds of nitrogen per acre 3-5 weeks after emergence. If the crop is overwintered, another such sidedressing should be applied in late winter, just prior to new growth.

PLANTING

Rows may be 18-36 inches apart and plants should be 1 1/2 to 3 inches apart. One to 1 1/2 pounds of seed will plant one acre.

Planting dates	Coastal Plain	Piedmont	Mountains
Spring	Feb 1 - Apr 15	Feb 15 - Apr 30	Mar 1
Fall	Aug 1 - Sep 15	Jul 15 - Sep 15	Aug

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CULTURE

No herbicides are cleared for this crop. Regular and shallow cultivation is essential to keep down weeds and grasses. Irrigation is beneficial, especially for the fall crop, since leafy vegetables require adequate moisture for continuous growth and high quality.

INSECTS*

A wide variety of insects and diseases similar to those of cabbage and broccoli may attack this crop.

HARVESTING

Broccoli-raab is often harvested for greens similarly to mustard, kale and turnip greens. Leaves are cut when 4-8 inches high and sold loose in bushel hampers or tied in 1-2 pound bunches.

This crop goes to seed readily. It makes several small flower heads which are cut, just as in regular broccoli, before the flower buds open. These flower heads usually average about 1 to 1 1/2 inches in diameter. The stems of these heads are cut to a length of 8-10 inches and tied in bunches of 1-2 pounds each. Occasionally, it is sold loose in bushel baskets. A bunch usually contains about 1/3 to 1/2 flower heads and stems and the remainder is leaves. In cooking, the leaves, stems and flower heads are cooked and eaten just as turnip greens or regular

broccoli.

When tying in bunches use soft string, rubber bands, tape, raffia or similar material and make sure bunches are tied tightly and neatly. Remove all discolored or damaged leaves. Wash thoroughly in clean water to remove sand and dirt.

If weather is warm and hauling distance is over 50 miles, crushed ice should be used to retain quality. When hampers or crates are used, put crushed ice in the middle and on top of each crate. When hauling loose in bulk, put crushed ice on top of the stack. In hauling to market cover the truckload with a tarpaulin to prevent drying out.

If planted early in the fall or late in the spring this crop requires about 60-65 days from seeding to first harvest of the flower heads. If planted in the late fall harvest is usually delayed until late winter or early spring.

The fall varieties will withstand fairly cold winter weather but even these varieties will be killed if temperature drops much below 15 F, or if heavy freezes occur rather suddenly after a prolonged warm period.

* Contact the county extension office for identification of the insect problem and control.

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BROCCOLI PRODUCTION GUIDE FOR WESTERN NORTH CAROLINA
Jeanine M. Davis, Extension Horticultural Specialist
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INTRODUCTION

Broccoli is a popular vegetable for use both fresh and frozen. The edible portion of the broccoli plant consists of the upper stem and the unopened flower buds. Broccoli is a cool season crop that is closely related to cabbage, cauliflower, kale, mustard and turnips. It can be grown in western North Carolina as either an early (spring) or a late season (fall) crop at the lower elevations (below 2500 ft.) or during mid-summer at elevations above 2500 feet.

Rapid, uninterrupted growth is required for high quality and good yields. Marketable heads must have tightly clustered buds with no yellow flower color. They must be free of insects. Formation of small, button heads and premature flowering (bolting) may result from exposure of transplants to periods of plant stress that interfere with vegetative growth. This can be a serious problem with large transplants and early maturing varieties. Extremes of temperature, moisture or fertility appear to be causative factors. Providing protection during plant production, minimizing transplant shock, providing optimum moisture and fertility, and avoiding very early season plantings should minimize these problems.

VARIETIES

Green Comet (45 to 50 days) has been a reliable variety in the mountains for many years although stalk length is not always as long as commercially desired. Green Valient (83 days), Packman (45 to 50 days) and Baccus (50 to 65 days) also perform well. New varieties should be planted in limited quantities until local adaptability has been determined.

PLANT SOURCES

Broccoli transplants may be obtained from commercial sources or

produced in cold frames, hotbeds or greenhouses. Home-grown plants are preferred.

TRANSPLANT PRODUCTION IN HOTBEDS OR COLDFRAMES

Select a site with a southern exposure and a well drained, light soil. Soils that crust or bake should be avoided. Prepare the soil to a fine seedbed condition. Fumigate the soil for control of weeds, soil borne insects and diseases. (See extension bulletin AG-337 Production of Commercial Vegetable Transplants and the N.C. Agricultural Chemicals Manual for detailed information on fumigation.) Fertilize and lime according to soil test recommendations for transplant production. Approximately 33 lbs. of 5-10-5 or 6-12-6 may be broadcast and incorporated into a 9 x 100 foot bed.

Plant seed 0.25 to .5 inch deep in rows 4 to 6 inches apart at the rate of about 24 seeds per linear foot of row. Four ounces of seed should provide adequate transplants for one acre (about 14,000 plants). Firm the soil over the seeds to retain soil moisture. When two true leaves are visible, thin the seedlings to 1.5 inches between plants. Irrigate to maintain good moisture, but avoid keeping the plant bed too wet. Fertilize with a soluble fertilizer every 1 to 2 weeks.

Downy mildew is the predominant foliar disease problem in plant beds. Apply recommended fungicides at weekly intervals from the time of appearance of the first true leaves. The cabbage root maggot can be a serious problem especially in early spring plantings. An insecticide can be worked into the upper 3 to 4 inches of soil just prior to seeding for control of maggots. Aphids can be controlled with a soil insecticide application of disulfoton (Di-Syston).

Plants are ready to transplant when they are 5 to 6 inches tall. A light watering just prior to pulling the plants will reduce root damage and result in more rapid recovery from transplant shock.

TRANSPLANT PRODUCTION IN GREENHOUSES

Peat pots, cell packs or trays should be filled with a light, artificial potting medium. Sow seeds directly into the container and thin to one per cell at the two leaf stage. Irrigate frequently and fertilize every week or two with a balanced, soluble fertilizer.

SETTING OUT TRANSPLANTS

Exposure of transplants to low temperatures may cause premature bolting. Most years it is safe to set out transplants in mid to late April. It will ordinarily take about 8 weeks to produce transplants in outdoor beds for a spring crop or 5 weeks for a fall crop. It takes approximately 5 weeks to produce transplants in the greenhouse. For fall crops, plan to set out transplants in mid August.

Transplant 10 to 15 inches apart in 30 inch rows (21,000 to 14,000 plants per acre, respectively). Very vigorous varieties may require wider spacing and available equipment may dictate different row spacing. Transplant by hand or use a mechanical transplanter. Set deeply but leave upper leaves and bud exposed. Firm soil well around each plant and water, preferably with a transplant solution. An insecticide for root maggot control may be included in the transplant solution.

DIRECT SEEDING

Broccoli is often direct seeded for a fall crop. Seed in July and thin to desired in-row spacing when the plants have 3 to 4 true leaves.

SOILS AND FERTILIZATION

Broccoli will grow on a wide variety of soils. It performs best, however, on a well drained, medium to heavy soil which is high in organic matter. Adjust pH to 6.0 to 6.5 with lime. Fertilize according to soil test recommendations or use 700 to 1000 pounds of 10-10-10 fertilizer per acre. Broccoli requires extra boron (B) for normal growth. Apply 2 pounds actual boron per acre at planting, preferably as part of the complete fertilizer. Common sources of boron are Borax (11.4% B) or Solubor (20.5% B). (Caution: do not apply boron in the transplant solution). If side shoots are to be harvested, maintain vigor with additional sidedressings of 30 pounds of 10-10-10 at 2 to 3 week intervals.

WEED CONTROL

Weed control is important for production of quality broccoli. Any cultivation and hoeing should be shallow to minimize damage to the roots. For the latest herbicide recommendations see the N.C. Agricultural Chemicals Manual or contact your local county agent.

INSECT CONTROL

The most troublesome insects on broccoli in western North Carolina include root maggot (especially with early season plantings), flea beetles, aphids, cabbage worms and cabbage loopers. Recommended use of insecticides will result in essentially an insect free crop. Formulations of Bacillus thurengiensis are particularly effective against cabbage loopers

and caterpillars.

DISEASE CONTROL

The major foliar diseases of broccoli include downy mildew and Alternaria leaf spot. Control measures include close observations and sprays with recommended fungicides at first appearance and at 7 to 10 day intervals.

IRRIGATION

Broccoli is a succulent plant which requires continuous rapid growth for high yields and good quality. Uneven soil moisture will adversely affect growth. Irrigate with overhead or drip irrigation to maintain a constant supply of moisture.

HARVESTING

The marketable portion of the broccoli plant consists of the upper stem and the clusters of unopened flower buds. These "stalks" or "heads" should be cut while the clusters are still compact and before individual flower buds begin to open and show any yellow color. When mature, central heads usually measure 4 to 7 inches across and may weigh 0.3 to 1.0 lb each. Overmaturity is indicated by woodiness in the outer stem tissue, loosening and separation of the flower clusters and partial opening of the flowers with yellow color showing. Such stalks are not marketable. Depending on the variability within the variety, central stalks may mature over a two week period. At higher elevations or cooler temperatures, harvesting at 4 to 7 day intervals may be adequate to avoid overmature heads. At lower elevations and warmer temperatures, rate of maturity is accelerated and the harvest interval may need to be shortened to 2 to 5 days.

Maintaining good growing conditions past the time of harvest of the central head, including adequate moisture and fertility and a good pest control program, can result in the development of heads on the lateral shoots until frost. These will usually range from 1 to 4 inches in diameter and 0.1 to 0.3 lb in weight. Second and third commercial harvests of these side shoots is sometimes possible. Removing more of the main plant stem, along with the central head, will generally result in fewer, but larger, side shoots on the remaining portion of the stem.

PREPARATION FOR MARKET

Broccoli is very perishable and should be removed to the packing shed as soon as it is harvested, then trimmed, bunched, tied and cooled. Trim stems to 6 to 8 inches. Bind into 1.25 to 1.5 pound bunches using rubber bands or "twist-ties" and pack 14 to 18 bunches in a standard waxed carton for a net weight of 21 to 23 pounds. Broccoli is highly perishable and its color and quality deteriorate very rapidly after harvest under high temperatures. Therefore, it should be cooled as soon as possible after harvest. Cooling rapidly to near 32F and refrigerating is essential for broccoli that must be held for a few days before shipment. For medium to long distance hauling, icing and refrigerated transportation are essential. In addition, most supermarkets expect all broccoli to be iced.

YIELDS

Central head weight will vary with variety and growing conditions. Variety tests have produced average head weights, depending on spacing, variety and year, from 0.3 to 1.0 lb per head. Yields of central heads may range from 200 to 750 cartons (21 lb per carton) per acre. Two or more side shoots per plant,

averaging from 0.1 to 0.3 pounds per shoot, could provide from 50 to 150 additional cartons per acre. Good management and good growing conditions should result in average yields of 500 cartons per acre.

* Refer to the most current N.C. Agricultural Chemicals Manual for recommended materials, rates and application methods for insect, disease and weed control.

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Here is the information for a 100 foot row of BROCCOLI

Approximate yield is 100 lbs. at a spacing of 18-24 inches between plants.

You will need between 1/8 and 1/4 ounces of seeds.

Fertilizer rates :
::Manure (approximate): 120 lbs.
::Chemical (10-10-10): 5 cups.

BROCCOLI typically grow to a height of 18-24 inches.

This crop does well in a soil that is rich & loose with lots of humus and a little extra lime and with a pH range of 6.0-7.5.

Pick a spot that provides full sun.

Growing seasons: Spring: yes
Summer: no
Fall: yes
Winter: no

From seed to first harvest is nominally 16 weeks.

Seeds can be started indoors as early in the spring as 12 weeks before your growing areas last spring frost and then transplanted into the garden in about 7 weeks.

From transplant time to the first harvest is usually about 9 weeks with around 3 weeks of harvesting.

For the fall planting cycle, seeds should be started no later than 16 weeks ahead of your first fall frost.