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Agronomic management status in cauliflower cultural practices in Ethiopia for vegetable crop production technology

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Abstract
Cauliflower in Ethiopia is one of the several vegetables in the species Brassica oleracea in the family Brassicacea it is annual plant the reproduces by seed. Typically only the head (the white curd) is eaten. Cauliflower is low in flat low in carbohydrates but high in dietary fiber, water and vitamin c, posing a high nutritional density with vegetable production for cauliflower
Cauliflower is one of the most important cool season vegetables crops grown throughout the country and relished by the most of the people. Being a heavy feeder. Many applied research stations to conserve the richness of the gene pool and develop us formed on the production side
Cauliflower demands constant supply of large amount of nutrients and water for its luxury.
Yield of 50t/ha of cauliflower removes apparently 200kg Nitrogen 85 kg phosphorus and 279 kg potassium it is productivity depends up on the balanced fertilizer and is not adequately fertilize red considerable yield losses are apparent. In the context of Nepal cauliflower is grown as both seasonal and off seasonal vegetable. It is grown during cool summer months in highly elevations and can be successfully grown in winter in the tropical regions it is cultivated 34,065 ha of land with annual of 524,205 mt (MOAD 2013). Seedling should be grown in a well aerated medium which has a good water holding capacity. Heads of high quality are white to cream in color form and impact and packing normally the produce is sent the market loose or sometimes it is packed in gunny bags.

Keywords: cauliflower, cultivation, fertilizers, production

Introduction
Cauliflower (Brassica oleracea var Botrytis) is part of a large group of plants known as Cole Crops. Cole crops are a group (family) in the Brassicaceae or mustard family (previously Cruciferae or crucifers). It is an annual plant that reproduces by seed. Typically, only the head (the white curd) is eaten. The cauliflower head is composed of a white inflorescence meristem. Cauliflower heads resemble those in broccoli, which differs in having flower buds. Chien Yi Wang. 2003 [2].
Cole crops originated from the word caulis, meaning stem or stalk of a plant. Cole crops are biennials, but are generally grown as annuals. Cauliflower came from the Mediterranean region. The first description of cauliflower appeared in 1544.
Cauliflower is one of the cultivated varietals of cabbage. It is picked during the bud stage before it blossoms. The flowers are the parts that are most frequently eaten because they are the most nutritious It is commonly believed that cauliflower originated in the Middle East, and in Italy, since the 15th century. Cauliflower may have migrated to Europe from Cyprus, and during the 16th century, it spread in popularity from Italy to France. New York, Orange Judd Company, (1918) [1].
The brassica family is quite cold resistant, making them well adapted to cool season production. With most Cole Crops, a cold period is necessary for flowering, however each crop has its own temperature tolerances. Young, hardened cauliflower plants can withstand temperatures of 0C for less than 36 hours. The minimum and maximum growing temperatures for cauliflower are 0 and 300C, with the optimum growing temperature for this crop between 15 and 20C. The minimum, optimum and maximum germination temperatures for cauliflower are 7, 27 and 29 0C respectfully.

World Production
At present, cauliflower is grown in more than 90 countries and its production is more than 20.9 million metric tons. In terms of production, People's Republic of China ranks first followed by India, Spain, Mexico, Italy, France, United States, Poland, Pakistan, Egypt and United Arab Republic, amongst others. Once India stood first, however, at present India is in the second position in its Production. As far as the share in the world production is concerned, China has 43.26 per cent, India 32.31 per cent and that of Spain is 2.53 per cent. As a whole, more than 75 per cent of the world production is from Asian region itself.

Nutritive value and health benefits
Cauliflower is rich in vitamins A and C. Cooked cauliflower contains a good amount of vitamin B and a fair amount of protein in comparison to other vegetables.
Table I

Table 1: Nutritive Value of Cauliflower per 100 gm of Edible Portion

Moisture	90.8 gm
Protein	2.6 gm
Fat	0.4 gm
Minerals	1.9 gm
Fiber	1.2 gm
Other carbohydrates	4.0 gm
Calories	30.0 gm
Calcium	33.0 mg
Magnesium	20.0 mg
Phosphorus	57.0 mg
Iron	1.5 mg
Vitamin C	56 mg
Sodium	53.0 mg
Potassium	138.0 mg

Source: USDA (2014).

Objective

To review production technology on cauliflower crop.

Methdology

Review literature from Internet, Books and journals, unpublished document.

Climate and soil requirement

Cauliflower is a cool-season crop, and produces the best quality heads at temperatures between 15oC and 20oC. Depending on the stage of growth, the cauliflower plant requires 1 to 2 inches of moisture per week. Excessive moisture during the first 2-3 weeks after transplanting (4-5 weeks after direct-seeding) increases the incidence of root diseases and may cause cauliflower to "button" (form heads prematurely). Prematurely-formed heads are generally too small to market. They are also usually yellow, because the plant's leaves have typically not yet developed adequately to protect the curd from direct sunlight (see "Tying" section). If cauliflower roots are under water for over 24 hours, plants generally die. Cauliflower is the most sensitive of the cole crops to adverse weather. Mature cauliflower plants can withstand temperatures as low as 25o F for several hours late in the fall without damage to the curd. However, young plants subject to freezing temperatures often "button," or suffer from "blindness"--that is, they do not develop a head.

Warm temperatures can also promote disorders. Cauliflower heads maturing at temperatures above 85o F (29oC) may suffer from leafy head, richness (over-mature florets), discoloration (generally purple or green in color), soft and loose heads, or poor "wrapper leaf" development. Good development of wrapper leaves is needed to assure that the curd maintains its white color. And also High temperatures during cauliflower production delay maturity and increase vegetative growth and cool temperatures hasten maturity and may induce 'bolting'. Bolting is the premature formation of seed stalks. Fluctuating temperatures may induce some cauliflower cultivars which have begun heading, to revert back to vegetative phase which results in poor quality curds.

Crop varieties

The cauliflower (Brassica oleracea L. var. botrytis) plant belongs to the family Cruciferae. Its varieties are very responsive to temperature and photoperiod. It is therefore, very important to sow the appropriate variety at right time. Early varieties if sown late produce "button" head and late varieties if sown early will go on giving leafy growth and will produce curds very late. Early-season cultivars mature approximately 50 to 55 days after transplanting.

Cultural Practices

Seedling Production

Seedlings should be grown in a well-aerated medium, which has good water holding capacity and at a pH of around 6.5. Generally, peat, bark and vermiculite mixes are used. Media problems typically include excessive tannins and low air filled porosity, which results in poor drainage and the buildup of green mound. The medium should be pre-enriched and the seedlings should be fertilized. For optimum germination, the seedling trays should be placed in a germination chamber, at 20 °C with high relative humidity. The seedlings should be moved to the tunnel at the first sign of germination. The ideal temperature for seedling cultivation is 20 °C. Seedling management is a critical factor in cauliflower production, as the following factors related to seedling production may result in physiological disorders:

Seedbeds

A more normal method is to sow in well-prepared seedbeds and to transplant the seedlings when they are sufficiently developed. The soil and fertility requirements for seedbeds are the same as those for the land. Soils which cap should be avoided. Seedbeds should not be made on any site where crucifers have been grown within the past three years. Sites for seedbeds should not be exposed to very strong winds, but there should be good air movement to reduce disease incidence. Avoid sites too close to rivers or streams, or where dew is heavy, for the same reason. However, easy access to irrigation water is essential. The site should be fully exposed to the sun, and not too close to competitive tree roots.

Seedbeds should have a firm, level surface; low spots become too wet at times and high spots are often too dry. Beds should be no more than 1 m in width and of any convenient length, with narrow access paths between them. They are often raised a few centimeters above the normal soil surface to reduce the chance of water-logging should heavy rains occur. Use a minimum of 300 square meters of bed for every 500 g of seed sown. Denser plantings will tend to produce unsuitably long, thin, lanky seedlings, which do not perform well.

Seed is sown thinly to a depth of not more than 15 mm, in rows drawn 150 to 200 mm apart. Although seed size (usually 200 to 300 seeds/g) and germination do vary, a rule of thumb is to plant about 60 to 70 g of seed for every 10 000 transplants required, where seedbed conditions are good. Many growers plant about 10% more seed than they require, to ensure that sufficient seedlings are available to fill the entire land.

Frequent light irrigations are necessary to prevent drying out of the top soil in which the seed is planted. Gradually increase the interval between irrigations to about 7 days when the plants are Well-established. Drenching the soil just after emergence with Previcur N or Pro plant can reduce the incidence of "damping-off", caused by various soil fungi.

Spray the young seedlings (weekly) with a suitable fungicide as a routine spray or at the first signs of Downy Mildew. The danger

of outbreak of seedling diseases rises considerably under conditions of overcrowding, inadequate ventilation and poor drainage from the seedbed.

Spray with sodium or ammonium molybdate when the seedlings are 3 to 4 weeks old where molybdenum deficiencies are known to occur, and follow this a week later with a slobber spray where the soil is deficient in boron.

Keep the seedlings moist and growing strongly for 3 to 6 weeks or until they are 7 to 10 cm tall. Then reduce watering over the last 7 to 10 days (but do not allow the plants to wilt severely) in order to harden them to withstand the shock of transplanting. Give the seedbeds a good soaking the day before transplanting in order to restore a good water regime in the seedlings, and to facilitate lifting of the plants with minimal root damage.

Short, sturdy, slightly hardened seedlings about 10 to 15 cm tall, and with 4 to 5 true leaves, transplant and perform better than soft lanky, etiolated plants. The latter develop as a result of sowing too densely (seedbed area is too small), over-use of nitrogen fertilizers and over-watering. Under warm conditions, cauliflower seedlings may reach the required size within 4 to 5 weeks, but under cooler conditions may take 7 or 8 weeks, even with good seedbed practice. Young plants of the required size yield better than older ones. Only those plants which have reached the desired size are used for transplanting. Those developing more slowly may be transplanted slightly later when they are more developed, but are ultimately less likely to perform as well.

Seed Trays

As an alternative to open seedbeds, most commercial and many small-scale growers are produce their plants in Styrofoam or similar trays (the so-called seedling system), or purchase plants from specialized nurseries who use this system. Whilst this system has certain advantages, particularly for those growers who cannot produce seedlings well in open seedbeds, there are also some disadvantages. Even comparatively poor or off-type plants (so-called sibs) are often usable from such seedlings, but would probably not be used from seedbeds, and the high cost of transplants may cause some growers to revert to open seedbeds, particularly for open-pollinated varieties or those with less expensive hybrid cultivars. However, there is a saving in seed cost, and seedlings transplant more successfully, and with most growers perform better, with a more uniform, concentrated maturity, than do seedlings raised in seedbeds.

Spacing

A general spacing of between 28 000 and 35 000 plants per hectare is recommended. Spacing and plant population affect head size, head shape and yield. Should the specific market demand be for large heads, then wider spacing and lower population will be adopted for any specific variety than where the market prefers smaller heads. Generally speaking it is found that most growers tend to under-plant, i.e. have lower than optimum population. Cauliflowers:

Large-Framed Varieties: 75cm to 90cm x 500 mm to 600 mm (about 22 000 Plants per hectare).

Small-Framed Varieties: 600 mm to 750 mm x 400 mm to 450 mm (about 35 000 plants per hectare).

Fertilization

The soil is a resource that needs to be managed and monitored meticulously. It is essential that the soil samples of the intended growing area are analyzed by an accredited laboratory to determine the nutrient status of the soil. Based on soil analysis results a fertilization program can then be developed. This program is obviously specific for the type of soil that was sampled and subsequently analyzed. This exercise should be done every season or every time a new crop is planted on the land. In addition to having soil samples tested, the water quality should be analyzed because water quality can have a direct effect on the growth of the plant. For example, irrigation water with high calcium levels can increase the soil pH. Being a heavy feeder, cauliflowers require fertile soils. Soils must be fertilized according to soil analysis results. General recommendations:

- N-200-240kg/ha. 60-80 kg/ha at pre-plant. Top dress balance at 7, 14, 21 & 28 days after transplant, P - 50-60kg/ha, K - 250kg/ha

Irrigation

The availability of water can be critical to successful production. In the case of direct seeding, plan to irrigate every three days until the seedlings are established. Steady, even growth of cauliflower plants is necessary for high quality and yields. Irrigation may also be used to cool plants during periods of high temperature. Fertilizer could be applied through an irrigation system. Cauliflower requires a regular water supply of 25 mm every 5 to 7 days. Total water requirement is approximately 440mm.

The most critical moisture period is during head development. Irrigation at the wrong time can cause problems such as head rot of cauliflower. Sprinkler, furrow and drip irrigation are used in cauliflower production. They are cool-season, moisture-loving plants, which should never be exposed to drought-stress.

Until the plants are well-established after transplanting, they should be kept continually moist, with no more than 25% of the available water being used before re-watering. Up to about the halfway growth stage no more than 40% depletion of available water should be allowed. Thereafter the soil may be allowed to dry a little more, but irrigation should nevertheless take place as soon as 50% of available water is depleted.

Cauliflower, especially, should not be allowed to wilt once curds have formed as, apart from reducing yield, the curds may become exposed to the sun and discolor as a result. (Department of Agriculture, Forestry and Fisheries, 2012) [4].

Crop Rotation

A general guideline to follow concerning crop rotation is that a crop should never follow itself. Continuous cropping of any crop will result in an increase of disease and insect pressure and possibly a reduction in yields. A proper rotation will include

growing different botanical families on the same piece of land, in sequential seasons. The table below outlines some of the common botanical families vegetables belong to. By rotating crops that leave a high volume of residue in the soil, soil fertility can be enhanced naturally. Crop rotation can also improve soil structure by alternating deep-rooted and shallow-rooted plants. Crop rotation plays a key role in an IPM programme by aiding in the suppression of diseases, insects and weeds. Crops within the same plant family tend to be susceptible to the same pests, therefore rotation of non-susceptible crops for several years allows all plant material to decompose and pest cycles to become disrupted. Without the presence of susceptible plant material, the number of disease and insect organisms will begin to diminish. Crop rotation aids in weed control because the growth habit of each crop differs, which causes a decrease in a weed's' ability to compete for space.

Tillage practices and timings are different for each crop group, resulting in a decrease in a weed's ability to establish permanently. Because of disease and insect pressures it is best not to plant cauliflower more often than once every four years. Brassica crops use a lot of nitrogen so it may be beneficial to plant a legume crop before cauliflower.

Cauliflower has an intermediate root depth that will aid in improving soil structure and aeration. This crop has small seeds which will require a finely manicured seedbed; therefore previous crop residue will not be tolerated. If transplants are used, the roots can tolerate some plant residue, but too much will negatively affect root growth.

Tying

Cauliflower for processing is not normally tied. When this is done to keep heads white, leaves are usually gathered around the head at about the time that they are 2 cm in diameter. Leaves are held together with rubber bands or string. When several tyings are needed, use different colored rubber bands. This facilitates harvesting by allowing all plants with the same color band to be harvested at the same time.

Thinning

After the first true leaves have formed, the plants must be thinned so as to leave 1 plant at each location (about 3 weeks after seeding). Avoid delay in thinning as thinning large plants results in too much disruption of the remaining plants, contributing to an uneven harvest.

Packaging

Normally the produce is sent to the market loose or sometimes it is packed in gunny bags. However, it is advisable to pack it in bamboo or wooden baskets to reduce damage in transit. When packing is done in gunny bags, the inner leaves covering the curd surface are left intact and rest of outer leaves is removed. When curds are transported loose, most of the leaves with top portion are retained and a few outer whorls along with damaged leaves are cut off.

Storage and Conditioning

Cauliflower keeps for 2 to 6 weeks at 0 0C and 95% relative humidity. Heads should be cooled to 5 0C or below soon after harvest. Both hydro cooling and vacuum cooling are effective methods to remove field heat. In addition, forced-air cooling can be used. Never use ice on cauliflower. Cauliflower that is destined for storage is preferable cut slightly immature, otherwise the curds may separate. Controlled atmospheres do not extend the storage life of cauliflower and may cause off-odors, softening or discoloration. Wilting, browning, yellowing of leaves and decay are likely to increase if stored above 5 OC. Slightly immature and compact heads keep better than more mature ones. Cauliflower is very sensitive to temperature fluctuations during storage and such fluctuation causes darkening of curds. Exposure to ethylene during storage will cause more rapid leaf yellowing and abscission.

Controlled atmosphere (CA) is not recommended because it induces off odors and flavors, which can be detected only in the cooked products. Dr. Viliam Zvalo, &Alana Respondek, (2007) [5].

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