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8. Amaranth

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Abstract:

The demand for food is increasing, not only to meet food security for growing populations, but also to provide more nutritious food, rich in good quality proteins and nutraceutical compounds. The amaranth (Amaranthus hypochondriacus) plant, in addition to its high nutritive and nutraceutical characteristics, has excellent agronomic features. The objective of the present study was to analyze some physical and proximal-nutritional properties of amaranth seeds obtained from different varieties grown in arid zones and characterize their phenolic acids and flavonoids. Two commercial (Tulyehualco and Nutrisol) and two new (DGETA and Gabriela) varieties of A. hypochondriacus *were grown at the Mexican Highlands zone. Tulyehualco and DGETA varieties had higher seed yield of 1475 and 1422 kg* ha^{-1}*, respectively, comparable to corn and soybean production in agricultural areas. Gabriela had the highest protein content of 17.3%, but all varieties had an adequate balance of essential amino acids. Polyphenolsas rutin (4.0–10.2* $\mu g\ g^{-1}$ *flour) and nicotiflorin (7.2–4.8* $\mu g\ g^{-1}$ *flour) were detected. Amaranth can be cultivated in arid zones where commercial crops cannot be grown; the seeds besides their well-known nutritive characteristics could be a source of phenolic compounds of high antioxidant properties.*

Common Name: Slender amaranth or green amaranth

Botanical Name: Amaranths spp.

Family: Amaranthaceae

Chromosome Number: 2n = 32

Origin: Central America

Vegetable amaranth (*Amaranthus spp.*) known as chaulai in Hindi, it is the most common leafy vegetable grown during summer and rainy season in India. The leaves and tender stems of amaranth are rich in protein, minerals like calcium, iron, zinc, copper,

manganese, potassium, and vitamins such as vitamin a (carotene), vitamin c, folic acid, thiamine, niacin and riboflavin. Crude protein content in the leaf's ranges from 20-32% on dry weight basis, widely grown as a leafy vegetable in Southeast Asian. Amaranth plants typically are annuals or short-lived perennials. The stems often are reddish in colour and sometimes are armed with spines; they bear simple alternately arranged leaves and often feature a pinkish taproot.

Figure 8.1: Amaranth

8.1 Botany and Taxonomy:

Amaranthus cruentus is an annual herbaceous plant which reproduces only by seeds and has a short growing period: of 4–6 weeks. It produces one dominant, large, central root (tap root). Thick stems are often straight and branched, 0.1 to 2.0 m in height, ribbed, and red dyed. At maturity, the whole plant may be reddish. *Amaranthus* shows a wide variety of morphological diversity among and even within certain species. *Amaranthus* is part of the Amaranthaceae that is part of the larger grouping of the Carophyllales. Most of the *Amaranthus* species are summer annual weeds and are commonly referred to as pigweeds. The nutrients in amaranth can offer significant health benefits as a part of a healthy diet. It's a source of vitamin C, which is vital to the body's healing process because it helps process iron, form blood vessels, repair muscle tissue, and maintain collagen.

Climate and Soil Requirement: vegetable amaranth grows weel within a temperature range of 22-33 ^{0}C. It's a C_4 plant hence; it is grown successful in hot summer and humid condition of kharif. Amaranthus grows on loose and friable soils with high organic matter content. It grows best in light soils, with a pH of between 5.5 and 7.5. Tolerate a soil pH form 4.5-8 with 6.5-7.0. Amaranthus tricolor is relatively salt tolerant.

Commercial Varieties/Hybrids: Vegetable Amaranth varieties come in various leaf colours such as white (light green), dark green, red, purple and variegated. Amaranth genotypes are available which bolt only under short day conditions.

Kashi Suhaavani (VRAM-42): Soft succulent green leaf, delayed flowering and high yield potential (30-33 t/ha). Growing for summer and rainy season. Sowing time is February March and June-July in northern India. Seed rate 2.5 kg ha.

Arka Arunima: It is a Fast-growing multicut variety with purple-colored leaves and stem. It has got excellent cooking quality and is rich in vitamins and minerals. Resistant to white rust, yields 26-28 t/ha from 3 cuttings in 60 days' duration.

Arka Samraksha: It is a high yielding amaranth variety, with high antioxidant activity of 499mg (AEAC units) and minimum nitrate content of 27.3 mg and 1.34g of oxalates per 100g fresh weight of leaves. It is a pulling type amaranth variety with green leaves and stem, yields 10.9t/ha in 30-35 days' duration.

Arka Varna: It is a high yielding amaranth variety, with high antioxidant activity of 417mg (AEAC units), nitrate content of 37.6mg and 1.42g of oxalates per 100g fresh weight of leaves. It is a pulling type amaranth variety with green leaves and pink stem, yields 10.6 t/ha in 30-35 days' duration.

Arun: its high yielding variety of Amaranth, released from the Kerala agricultural university, leaves are deep red in color and average yield is 20 t/ha.

CO 1: It belongs to A. dubius. It is suitable for growing tender greens and immature stems that are thick and fleshy. The leaves of this variety are broad, thick and dark green in color. The first harvest can be made at 25 days after sowing. The seeds are very small and black in color.

CO 2: Some of the most common commercial amaranths are selections of A. tricolor in various leaf colors such as light green, dark green, red, purple, and variegated. The leaves are lanceolate (shaped like the head of the lance).

The stems remain tender and succulent and hence it suitable to be harvested in 30 days after sowing. Both the leaves and stems of this plant can be used as vegetable.

Mohini: it is a high yielding variety of amaranth, released from the Kerala agricultural university. Its leaves are green in color and average yields 25 t/ha.

Pusa Kirti (A. blitum): It's a Green leaved variety with green and thick stem; leaf lamina broad ovate; ready for harvest in 30-35 days and extends up to 70-85 days; yield 55 t/ha; specifically suited for summer.

Pusa Kiran: Its leaves are glossy green with broad ovate lamina. The stem is glossy green. It is suitable for kharif. It becomes ready for first picking 21–25 days after sowing, the duration of harvest being 70–75 days.

Pusa Lal Chaulai: It is suitable for kitchen gardening as well as for commercial cultivation in northern plains. It is suited for growing in both summer and rainy seasons. On an average, it yields 45–50 tones/ha.

RNA 1 (A tricolor): it's released from Y. S. R. Horticultural University.

Sowing/Planting Time and Methods: Amaranth should be sown during mid-march for summar crop and mid-July for kharif. It is planted either by direct seeding or transplanting depending on the availability of seed, labour and growing season. Amaranth requires thorough land preparation and a well-prepared soil for good growth. Plant from mid-spring to early summer by sowing seeds barely covered with soil in uniform rows. Keep soil moist until the seedlings sprout. Weed by hand until the plants are 4 inches (10 cm) tall, gradually thinning plants to 18 inches (46 cm) apart. As the plants grow, they will shade out most summer weeds.

Seed Rate and Seed Treatment: The seed rate is about 2 kg/ ha for direct sowing and 1 kg for transplanted crop. Amaranthus seeds are very small, so they should be sown shallow, about 1.5 cm deep, mixed with fine soil or sand for even distribution.

Nutritional and Irrigation Requirements: For clipping type of Amaranthus (CO3), a higher fertilizer dose of 75 kg of nitrogen, 25 kg/ha each of phosphorus and potash is recommended. Since amaranth is first grown as a short duration crop, it requires plenty of water for growth and high yield. In summer, frequent irrigation is required at 4–6 days' interval. Similarly, in kharif, irrigation is scheduled as per the moisture content of the soil. Drip irrigation is recommended in areas with limited water supply and has high water-use efficiency.

Intercultural Operations, Weed Control and Mulching: A seedbed free of weed seeds allows amaranth seedlings to get a head start on the weeds and establish a canopy that can shade out emerging weed seedlings. Mulching is recommended to reduce weed competition, soil compaction and erosion; mulching also conserves soil moisture.

8.2 Physiological Disorders:

Bolting: Premature flowering or bolting is a serious problem in cultivation of amaranth. Quality and yield are deteriorated after flowering. Bolting is usually associated with planting of short-day varieties during November-

December, deficiency of nitrogen, extreme high temperature and poor soil aeration. Practices like rising of crop at ideal time depending on locality, frequent application of nitrogen fertilizers and manures and keeping soil loose by light hoeing prolong flowering.

Harvesting: The young amaranth seedlings grown for commercial purposes are often uprooted when they are 8-10 cm tell (3-4 weeks after sowing). Whole plants are pulled form soil with roots, washed and tied in bundles. In case of multiple harvests, the first cutting can be made 3 weeks after sowing. Subsequent 4-5 cuttings are made at 10-15 days' interval depending upon the vegetative growth.

Post-Harvest Management: The leaves lose water rapidly during storage, particularly at higher temperature resulting in rapid wilting, decrease in chlorophyll, ascorbic acid and soluble protein content and an increase in amino acid content. Hence, harvest during the cooler time of day, such as early morning or late afternoon. It can be stored for 6 days at 24- 28^0C temperature. Packaging of amaranth leaves in low density polyethylene bags improves its shelf- life and nutritive value.

8.3 Plant Protection:

Insect pests and disease must be controlled to ensure good yield and marketable quality. Amaranthus is susceptible to damage by foliar insects such as leaf miners, leaf miners,

8.3.1 Disease:

Alternaria Leaf Spot (Alternaria Tenuissima): Dark brown to black, circular to oval, necrotic lesions of <1 mm to 7 mm diameter appear on the leaves.

Figure 8.2: Alternaria Leaf Spot

Cercospora Leaf Spot (Cercospora sp): Numerous small brown circular spots appear on the leaves which in the beginning are small, roundish with concentric rings but later increase in size and coalesce.

Figure 8.3: Cercospora Leaf Spot

White Rust (Albugo Bliti): White, blister like circular or irregular pustules appear on the lower surface of the leaf. A yellow patch develops opposite each pustule on the upper surface of leaf. This disease is serious especially during kharif. The important pests that attack the plant are described here.

Figure 8.4: White Rust

8.3.2 Pests:

Aphids (Aphids spp): Aphids suck the plant sap, causing leaves to curl and become unattractive. Heavily infected plants have wrinkled leaves, stunted growth, and deformed seeds. Young plants may dry out and die.

Figure 8.5: Aphids

Bugs (Lygus spp): The Lygus bug sucks juice form flowers and seed, thus preventing flowers form producing seeds and reduces seed weight in the seed crop of vegetable amaranth.

Figure 8.6: Bugs

Weevils (Hypolixuds Haerens): Adult weevils feed on leaves and the larvae (grubs) bore into roots and stems, causing rotting and potentially lodging and predisposition to diseases. The larvae bore through stem to the root collar hollowing the stems, making the stem more susceptible to wind breakage. The larvae pupate in the stem.

Figure 8.7: Weevils

8.3.3 Seed Production:

Seed production is a highly specialized. Seed production of certain crops may be easier than others depending on maturity period, mode of reproduction, susceptibility to seed borne diseases and seed multiplication factor. Important species of amaranth are A. cruentus, A. caudatus, A. Hypochondriacus, A. tricolor and A. Dubius.

Isolation Distance: Foundation seed 400m & Certified seed 200m.

Rouging: Rouging ensures that the seed lot produced is of the highest genetic, sanitary and physiological quality possible Rouging is done by regularly inspecting the seed field and removing any off-types or diseased plants.

The entire plant should be removed by pulling or cutting before it flowers. Characters to be considered when rouging are: - General Appearance Leaf color and shape Color of flowers in spike Physical characteristics of spike Plant Height Diseases Prevalence Maturity period.

8.4 Harvesting:

Different varieties mature at different times.

- When seed is mature panicles of individual plants should be cut down, laid on tarpaulins, polythene sheets or woven large mats and dried.
- The seed is then threshed winnowed and collected in containers for storage.
- When we wait too long to harvest, seeds might shatter on the ground reducing the yield.

Seed Yield: This will depend on variety of Amaranth. This can be from 200-300 kg/ha for species like tricolor and 1-1.5M T/ha for A. cruentus.

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