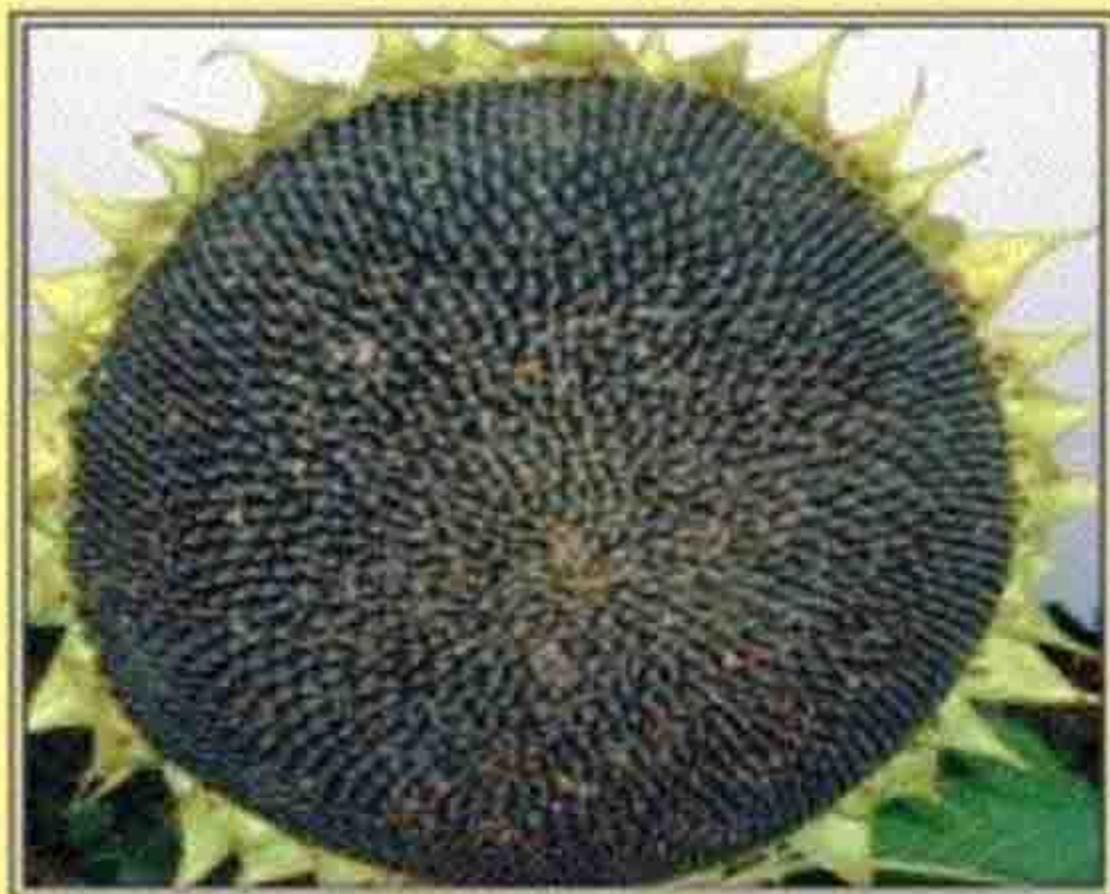


RESEARCH ADVANCES IN
SUNFLOWER
(Helianthus annuus L.)

MAITI, SINGH, PUROHIT AND VIDYASAGAR



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(*Helianthus annuus* L.)

Editors: R. K. Maiti, V. P. Singh, S. S. Purohit & P. Vidyasagar

ADVANCES IN AGRONOMY - 1

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Preface

Sunflower (*Helianthus annuus* L.) is one of the few crop species that originated in North America (most originated in the fertile crescent, Asia or South or Central America). It was probably a camp follower of several of the western native American tribes who domesticated the crop (possibly 1000 BC) and then carried it eastward and southward of North America. The first Europeans observed sunflower cultivated in many places from southern Canada to Mexico.

Sunflower was probably first introduced to Europe through Spain, and spread through Europe as a curiosity until it reached Russia where it was readily adapted. Selection for high oil in Russia began in 1860 and was largely responsible for increasing oil content from 28% to almost 50%. The high-oil lines from Russia were reintroduced into the U.S. after World War II, which rekindled interest in the crop. However, it was the discovery of the male-sterile and restorer gene system that made hybrids feasible and increased commercial interest in the crop. Production of sunflowers subsequently rose dramatically in the Great Plains states as marketers found new niches for the seeds as an oil crop, a birdseed crop, and as a human snack food. Production in these regions in the 1980s has declined mostly because of low prices, but also due to disease, insect and bird problems. Sunflower acreage is now moving westward into dryer regions; however, 85% of the North American sunflower seed is still produced in North and South Dakota and Minnesota.

The name *Helianthus*, being derived from *helios* (the sun) and *anthos* (a flower), has the same meaning as the English name Sunflower, which it is popularly supposed has been given these flowers from a supposition that they follow the sun by day, always turning towards its direct rays. In Peru, this flower was much revered by the Aztecs, and in their temples of the Sun, the priestesses were crowned with Sunflowers and carried them in their hands. The early Spanish conquerors found in these temples numerous representations of the Sunflower wrought in pure gold.

Plants are tall, hardy, annual or perennial herbs, several of which are grown in gardens, being of easy cultivation in moderately good soil, and that useful plant of the kitchen garden, the Jerusalem Artichoke (*Helianthus tuberosus*), is also a member of the genus. It is an annual herb, with a rough, hairy stem, 3 to 12 feet high, broad, coarsely toothed, rough leaves, 3 to 12 inches long, and circular heads of flowers, 3 to 6 inches wide in wild specimens and often a foot or more in cultivation. Sunflower leaves are phototropic and will follow the sun's rays with a lag of 120 behind the sun's azimuth. This property has been shown to increase light interception and possibly photosynthesis.

What is usually called the flower is actually a head (formally composite flower) of numerous flowers (florets) crowded together. The outer flowers are the ray florets and can be yellow, maroon, orange, or other colors, and are sterile. The florets inside the circular head are called disc florets. The flower-heads are composed of many small tubular flowers arranged compactly on a flattish disk: those in the outer row have long strap-shaped corollas, forming the rays of the composite flower. Sunflower head displaying florets in spirals of 34 and 55 around the outside. The florets within this cluster are arranged spirally. Typically each floret is oriented toward the next by approximately the golden angle, producing a pattern of interconnecting spirals where the number of left spirals and the number of right spirals are successive Fibonacci numbers. Typically, there are 34 spirals in 1 direction and 55 in the other; on a very large sunflower you may see 89 in one direction and 144 in the other.

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To grow well, sunflowers need full sun. In temperate regions, sunflower requires approximately 11 days from planting to emergence, 33 days from emergence to head visible, 27 days from head visible to first anther, 8 days from first to last anther, and 30 days from last anther to maturity. Cultivar differences in maturity are usually associated with changes in vegetative period before the head is visible. They grow best in fertile, moist, well-drained soil with a lot of mulch. In commercial planting, seeds are planted 45 cm (1.5') apart and 2.5 cm (1") deep. For farmers not intending to grow it, the sunflower is considered a noxious weed. The wild variety will grow unwanted in corn and soybean fields which can have a negative impact on yields.

Sunflower is often classified as insensitive to daylength, and photoperiod seems to be unimportant in choosing a planting date or production area. Sunflower seeds will germinate at 39 °F, but temperatures of at least 46 to 50 °F are required for satisfactory germination. Seeds are not affected by vernalization (cold) in the early germination stages. Seedlings in the cotyledon stage have survived temperatures down to 23 °F. At later stages freezing temperatures may injure the crop. Temperatures less than 28 °F are required to kill maturing sunflower plants.

Sunflower being an edible oil of high commercial value, sufficient research activities have been undertaken on various fields of this economically important crop. The Sunflower is valuable an ornamental point of view. It forms one of the well-known crops in Russia, Spain, France, Germany, Italy, Egypt, India, Manchuria and Japan. The average acre will produce about 50 bushels of merchantable seeds, and each bushel yields approximately 1 gallon of oil, for which there is a whole series of important uses.

The oil is produced mainly in Russia, but to an increasing extent also in Roumania, Hungary, Bulgaria and Poland. In 1913 some 180,000 tons of oil

were produced, practically all of which was consumed locally. The oil pressed from the seeds is of a citron yellow colour and a sweet taste and is considered equal to olive oil or almond oil for table use. The resulting oil-cake when warm pressed, yields a less valuable oil which is used largely for technical purposes, such as soap-making, candle-making and in the art of wool-dressing. As a drying oil for mixing paint, it is equal to linseed oil and is unrivalled as a lubricant. The residue after the oil is expressed forms an important cattle-food. This oil-cake is relished by sheep, pigs, pigeons, rabbits and poultry. The seed makes excellent chicken-food and feeding fowls on bruised Sunflower seeds is well known to increase their laying power.

Every part of the plant may be utilized for some economic purpose. The leaves form a cattle-food and the *stems* contain a fibre which may be used successfully in making paper. The flowers contain a yellow dye.

The whole seed of sunflower (fruit) is sold as snacks and can be processed into a delicious peanut butter alternative, Sunbutter, especially in China, the United States, the Middle East and Europe. In Russia it is probably the most wide spread snack. It is also sold as food for birds and can be used directly in cooking and salads. The seed is rich in oil, which is said to approach more nearly to olive oil than any other vegetable oil known and to be largely used as a substitute. Sunflower oil, extracted from the seeds, is used for cooking (but is less cardiohealthy than olive oil), as a carrier oil and to produce biodiesel, for which it is less expensive than the olive product.

In prewar days, sunflower seed was sometimes grown in this country, especially on sewage farms, as an economical crop for pheasants, as well as poultry. The seeds of the large-seeded varieties are also much liked by Russians and are sold in the street as are chestnuts in this country. Big bowls of Sunflower seeds are to be seen in the restaurants of railway stations, for people to eat. Indian natives are also fond of the seeds. Roasted in the same manner as coffee, they make an agreeable drink, and the seeds have been used in Portugal and Russia to make a wholesome and nutritious bread. Sunflowers also produce latex and are the subject of experiments to improve their suitability as an alternative crop for producing hypoallergenic rubber. Additionally, the stem of a dead sunflower can dry out open wounds.

The present book Research Advances in Sunflower includes articles related to various aspects of sunflower like Germination and seedling establishment, Growth and development and productivity in sunflower, Physiological basis of crop growth and productivity, Cultural practices, Sunflower: an encounter with biotic factors that causes yield loss, Research advances in sunflower breeding, Food and oil science technology in sunflower, Sunflower biochemistry and biophysics and Biotechnology and molecular biology of sunflower.

The authors for different topics of this volume were chosen based on their expertise in the subject. They have their credit for active engagement in research with strong record of publications too. They are highly competent to synthesize a complete contemporary review of the relevant areas. The conviction was to produce a complete, wide ranging review of the topic with the help of their involvement and interest in the subject of course, without any compromise.

The arrangement of the chapters is aimed to describe first the fundamental and basic issues of sunflower. After anchoring the reader's interest convincingly, care is taken to navigate his interest into the applied aspects of the science and help him to obtain a wide yet deep knowledge about the subject.

This book is self-reliant record, since all the salient features are extensively covered in an elaborate and self-explanatory manner. This book as a treasured record for students of Seed Technology, Agriculture, Botany and Life sciences, not to speak of the scientists, and the academicians.

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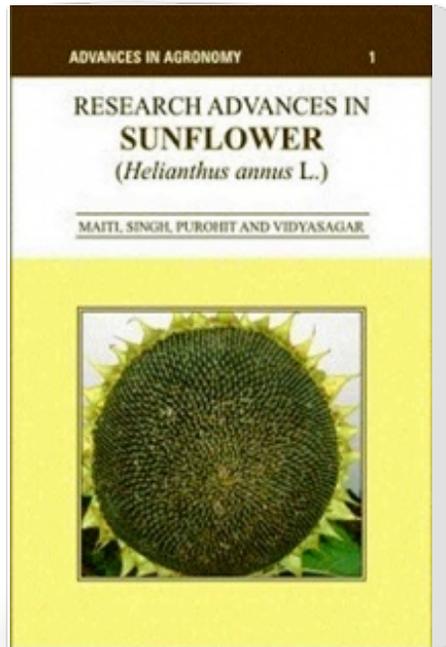
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