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Review Article

NIGER (*GUIZOTIA ABYSSINICA*): AN OVERVIEW

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ABSTRACT

Niger plant (*Guizotiaabyssinica*), is a herbaceous green plant with bright yellow flowers in the family Asteraceae. It is an important oilseed crop along with medicinal properties mainly grown in India and Ethiopia. Niger seed is used as a food for human consumption. Niger is also used as a green manure for increasing soil organic matter.Traditionally the seed powder is used as remedy for cough, oil in cases of rheumatism.It is generally used as spice in chutney, pickles and ketchup for adding taste in diet. Raw oil has low acidity and can be used directly for cooking. The inferior quality oil is used as illuminant. In Maharashtra, niger seed is consumed as chutney and largely used as spices.Niger seed can be used to treat the Rheumatoid arthritis. Niger seed is a novel biologically approaches to overcome against nematodes and arthropods. Niger seed can be used as poultices which can be applied to the surface of the body to relieve pain, itching, swelling and inflammation, abscesses, boils, etc. A Niger seed poultice is the most effective treatment available for many types of disorders.

Keywords: Niger,*Guizotiaabyssinica*, Ethiopia, oilseed.

INTRODUCTION

Niger (*Guizotiaabyssinica)* is an oilseed crop cultivated in Ethiopia and India. Niger plant (*Guizotiaabyssinica*), is a herbaceous green plant with bright yellow flowers in the family Asteraceae. It is an important oilseed crop along with medicinal properties. It is also known by several names like noog, niger, nyger, nyjerkhursani etc.[1,2,10]Niger seed (*Guizotiaabyssinica*) belongs to the same Compositae family as sunflower and safflower seeds. Ethiopia and India are the two major niger seed producing countries in the world.[3]It constitutes about 50% of Ethiopian,3% of Indian oilseedproduction. In Ethiopia, it is cultivated on waterlogged soils where most crops and all other oilseeds fail to grow and contributes a great deal to soil conservation andland rehabilitation.The genus Guizotia consists of six species, of which five, including niger, arenative to the Ethiopian highlands. It is a dicotyledonous herb, moderately to well branched and grows up to 2 m tall.[1]

Niger seed oil has linoleic acid as the principal fatty acid. Dietary fats and oils, rich in linoleic acid, have been reported to prevent cardiovascular disorders such as coronary heart disease, atherosclerosis, as well as high blood pressure. Also linoleic acid derivatives serve as structural components of the plasma membrane and as precursors of some metabolic regulatory compounds. The tocopherols and sterols compositions of Ethiopian and Indian niger seed oils and reported a-tocopherol and b-sitosterol as the major tocopherol and sterol. Tocopherols are essential forprotection of polyunsaturated fatty acid (PUFA) in plants and animals against oxidative deterioration. They exert their antioxidant effect by numerous biochemical and biophysical mechanisms, including scavenging active oxygen species and free radicals, and through action as efficient chain terminators in lipid auto oxidation reactions.[8]

The cold pressed oil is used as substitute for sunflower oil/ olive oil. Besides cookery, seed oil also said to be having utility in the preparation of soap, paint and other lubricants. The protein-rich seed content after oil extraction is said to be used as cattle feed, manure or fuel. Traditional claim suggests it as, healthy oil source, used in hot/dry climatic regions possessing rich nutritional value.[7]

BOTANICAL DISTRIBUTION

Niger is an annualdicotyledonous herb. Germination is epigeal and seedlings have pale

green to brownish hypocotyls and cotyledons. The leaves are arranged on opposite sides of the stem; at the top of the stem leaves are arranged in an alternate fashion. Leaves are 10-20 cm long and 3-5 cm wide. The stem of niger is smooth to slightly rough and the plant is usually moderately to well branched. Niger stems are hollow and break easily. The plant height of niger is an average of 1.4 m, but can vary considerably as a result of environmental influences and heights of up to 2 m have been reported from the Birr valley of Ethiopia. The niger flower is yellow and, rarely, slightly green. The heads are 15-50 mm in diameter with 5-20 mm long ray florets. Two to three capitulae (heads) grow together, each having ray and disk florets. The receptacle has a semi-spherical shapeand is 1-2 cm in diameter and 0.5-0.8 cm high. The achene is club-shaped, obovoid and narrowly long. The head produces about 40 fruits. The achenes are black with white to yellow scars on the top and base and have a hard testa. The embryo is white. Niger is usually grown on light poor soils with coarse texture. Itis either grown as a sole crop or intercropped with other crops. When inter cropped it receives the land preparation and cultivation of the main crop. In Ethiopia it is mainly cultivated as a sole crop on clay soils and survives on stored moisture.[1]

ORIGIN & CENTRE OF DIVERSITY

In Africa, *G. abyssinica* is largely found in the Ethiopian highlands, particularly west of the Rift Valley. Niger is also found in some areas in Sudan, Uganda, Zaire, Tanzania, Malawi and Zimbabwe, and the West Indies, Nepal, Bangladesh, Bhutan and India. India is the largest producer and exporter of Niger. It is cultivated in Andra Pradesh, Madhya Pradesh, Orissa, Maharashtra, Bihar, Karnataka, Nagar Haveli and West Bengal states of India of which Madhya Pradesh is the largest. During 1938 to 1948 India exported up to 6968 tonnes of niger annually to Western Europe, eastern Europe and North America.[1]

PROPERTIES

The niger seed contains up to 40% edible semidrying oil, 20.9% carbohydrate and 27.8% protein. Niger meal remaining after the extraction of oil contains approximately 30% protein and 23% crude fiber. Niger oil has a fatty acid composition typical for seed oils of the Asteraceae plant family (for example, safflower and sunflower) with linoleic acid being the dominant fatty acid. The linoleic acid content of niger oil was approximately 55% in seed grown in India and 75% in seed grown in Ethiopia. In general, the Ethiopian niger meal contains less protein and more crude fiber than the niger meal grown in India.[4]

Niger seed oil has linoleic acid as the principal fatty acid. Oleic acid was the second major unsaturated fatty acid. Niger contains two major saturated fatty acids palmitic and stearic.

The above fatty acids represent 91-97% of the fatty acid present. Palmitoleic, linolenic, arachidic, eicosenoic, behenic, erucic and lignoceric acids constituted less than 1% each.The oil content of niger seed ranges of 40–44 %. Niger seed oil, like sunflower and safflower oils, contains high content of omega-6 PUFA i.e. linoleic acid (63-75%).[8]

The Ethiopian seed contains about 40% oil with fatty acid composition of 75-80% linoleic acid, 7-8% palmitic and stearic acids, 5-8% oleic acid. The Indian types contain 25% oleic, 55% linoleic acids.[1]

MODE OF REPRODUCTION

Flower development, the extent of cross and self-pollination, and the time at which fertilization occurs are important criteria for conducting breeding work. In Ethiopia capitulum buds open approximately 2 months after planting. Flower anthesis begins early in the morning at about 6.00 hours and dehiscence of pollen begins 2 hours later and continues up to 10.00 hours under conditions at Holetta, Ethiopia. The style emerges covered with pollen but the receptive part rarely or never comes in contact with that pollen, a phenomenon that favours cross-pollination. A single head or capitulum takes 8 days and a field will require 6 weeks for completion of flowering.[1]

BREEDING METHOD

A genetic improvement programme for Niger must be based on its pollination behaviour. Because of its self-incompatibility nature, breeding procedures used in the improvement of cross-pollinating crops are the methods of choice for niger breeding. Mass selection is a powerful tool for crop improvement. In niger, this technique has been successfully employed for the development of an early to medium maturing, short plant type variety. The resulting variety was 9 days earlier maturing, 10 cm shorter in height and significantly higher yielding than standard niger varieties. The pollination behaviour of niger is similar to that of sunflower. Thus niger is an excellent candidate for hybrid variety development. The identification of genetic male sterility in India and recently in Ethiopia has opened the way for the exploitation of heterosis in niger. Six hybrids based on genetic male sterility, their parents, and local and national check varieties were evaluated for seed yield in India. The hybrids

exhibited 10-30%heterosis for seed yield over the better parent and 15-55% over mid-parent yields. No heterosis was observed for oil content except in a one hybrid combination.

A requirement for hybrid breeding is the availability of genetically diverse heteroticgermplasm. It is anticipated that Ethiopian and Indian nigergermplasm are genetically very different and might express high levels of heterosis for seed yield. A preliminary evaluation of Indian niger at the Holetta Research Centre in Ethiopiahas shown that Indian genotypes, when grown in Ethiopia, matured within 74 days compared with the 150 days of standard Ethiopian varieties. The Indian varieties also had higher seed weights than Ethiopian varieties.

Niger is attacked by a number of insects and fungal diseases. As modern high yielding, genetically uniform cultivars are disseminated, threats from diseases will increase which will require increased emphasis on disease resistance breeding. Wild species of the genus Guizotia could serve as sources for disease resistance gene which could be introgressed into the cultivated species through interspecific crossing.[1]

AGRONOMY

In India niger is planted as a rain-fed crop in 'kharif' and 'rabi' seasons. Generally it is planted from mid-June to early August for 'kharif', in September for the semi-rabi season and in December for 'rabi' season. The optimum sowing period varies from state to state.

In India, niger is sown as a sole or mixed crop with finger millet, castor, groundnut, soybean, sorghum, mungbean, chickpea and even sunflower. Niger has a low response to nitrogen and phosphorus fertilizer. In India, both nitrogen and phosphorus and farm yard manure are applied.

Correct timing of harvesting of niger is an important practice in reducing shattering. Traditionally, niger is harvested while the buds are still yellow and stacked to dry. Then the stack is taken up right over to the threshing ground. As niger seeds are loosely held in the head, threshing is easy.[1]

DIFFERENCES BETWEEN ETHIOPIAN AND INDIAN NIGER

The Ethiopian and Indian genepools differ in many respects as a result of geographical isolation. The Ethiopian niger has a tall plant, is later maturing and is a higher yielder. The Indian niger is earlier to flower and mature, and has a higher seed weight. The latest maturing Indian niger is earlier to mature than the earliest Ethiopian material. Both genepools are similar in numbers of branches per plant and oil content, but the fatty acid composition of the Ethiopian and Indian niger is quite different. The Ethiopian niger oil contains about 20% higher linoleic and 20% lower oleic acids than the Indian niger oil. Although this characterization is based on the material grown in the respective regions, this was also the case when a limited number of lines were grown together in Ethiopia.[1]

USES

Niger seed is used as a food for human consumption. Niger is also used as a green manure for increasing soil organic matter.[1,2]Traditionally the seed powder is used as remedy for cough, oil in cases of rheumatism. It is generally used as spice in chutney, pickles and ketchup for adding taste in diet. Raw oil has low acidity and can be used directly for cooking. The niger oil is premium oil because of high linoleic acid content (45-60%). Sometimes it is used as substitute to sesame oil. The inferior quality oil is used as illuminant. Niger cake is used as manure consists of 5 % N, 2 % P_2O_5 and 1.5 % K_2O. In Maharashtra, niger seed is consumed as chutney and largely used as spices.[7, 9]

Nigerseed can be usedto treat the Rheumatoid arthritis by application of oil on theparts where the pain is present. By periodically consumption of the nigerseed oil, the risk of the disordercan be avoided. Nigerseed is a novel biologically approachesto overcome against nematodes and arthropods.Nigerseed can be used as poultices which can beapplied to the surface of the body to relieve pain, itching, swelling and inflammation, abscesses, boils, etc.A Nigerseed poultice is the most effective treatmentavailable for many types of disorders.

STUDIES ON NIGER

Ajit Singh Bhatnagar et al (2013) worked on effect of extraction solvent onOil and bioactive composition of commercial Indian niger seed. For this purpose, niger seeds were subjected to solvent extraction using solvents of different polarity, viz., hexane, petroleum ether, chloroform, acetone, methanol and ethanol. The oil content of niger seeds obtained after extraction with solvents of different polarities was in the range of 31.8–41.3 g/100 g. The present study suggests that Indian niger seeds are a rich source of bioactive molecules.[3]

Matiwes Syume et al (2015)worked on nutrient composition of niger seed cultivated in different parts of Ethiopia. The levels of essential and non-essential metals in niger seed cultivated in different parts of Ethiopia were determined by flame atomic absorption spectrometry after wet

digestion using 2.5 ml of HNO_3 (69.5%), 1 ml $HClO_4$ (60%) and 0.5 ml of 30% H_2O_2 at 210°C for 150 min. Sampling was carried out randomly from nine different sites from Ethiopia and one sample from Eretria for comparison. The following metal concentration ranges (µg/g) were determined in niger seed samples, respectively: Na (159–736), K (5594–8203), Ca (340–680), Mg (2404–4656), Mn (13.4–34.3), Fe (31.6–370), Cu (9.5–61.2), Zn (23.4–46.2), Cr (4.0–16.8), Co (4.9–27.3), Ni (13.0–32.4), Pb (15.5–19.3) and Cd was not detected in all the sample.[4]

Sumeet Dwivedi et al (2014) worked on investigation of anti inflammatory activity of guizotiaabyssinica seeds and leaves. The aqueous and ethanolic extract of Guizotia Abyssinica leaves and seed were evaluated for anti-inflammatory activity in animal models. The result obtained indicates that the extract found to have significant anti inflammatory activity in rats.[5]

H. S. Patil et al (2006) summarized on self incompatibility, male sterility and pollination mechanism in Niger. The practical application of self-incompatibility in niger breeding is stillunexplored. Thus, the work on these aspects is reviewed and discussed in this paper. This paper presents the discussion of the past research on various mechanism favouring autogamy in niger and suggests the formulation of new breeding programme for improvement of this crop.[6]

Dr. N. Y. Bhoge et al (2019) worked on GC-MS study of seed oil of *Guizotiaabyssinica*cads plant as a source ofvegetable oils. *Guizotiaabyssinica* Cass plant as a source of vegetable oils, were subjected to Soxhlet-extraction with n-hexane and the extract analysed using a GC-MS followed by concentration in rotary evaporator. Separation of bioactive chemicals was carried out by column chromatography while studies by GC-MS which shows presence of following Hexadecane, Eicosane, n-Hexadecanoic Acid, cis-13-Octadecenoic acid, 9,12Octadecadienoic acid (Z,Z). It is used as medicinal plant.[7]

G.J. Bhavsar et al (2017) worked on characterization and quality assessment of mechanically and solvent extracted niger seedoil. In the present study an attempt was made to evaluate physico-chemical and nutritional quality of mechanically and solvent extracted niger seed oil. Solvent extracted exhibited higher yield of niger seed oil (39.34%) as compared to Mechanical extracted (29.23%).[8]

S. K. Krishna et al (2018) worked on production constraint analysis of niger in vertisol. From the results it may be inferred that adoption of full package of practice was more remunerative for getting higher growth and yield in niger. Among the various single production factor constraints, fertilizer and weeding and in combination of two factor production constraints, fertilizer + weeding, thinning + weeding and fertilizer + thinning were found to be crucial for reducing niger yield.[9]

Oimbo, L. M. et al (2018) worked on allelopathic effect of niger plant on abundance of selected weeds. Plants release many secondary metabolites to the environment that can be harnessed for important uses. These secondary metabolites are known as allelochemicals data analysis was done by ANOVA in Genstat and results presented using graphs. Results showed that Niger plant enhanced bean growth and development whereas it inhibited the germination and growth of some weeds i.e. field mustard, broom weed, double thorn and couch grass. It was concluded that Niger plant exhibited negative allelopathy on the weeds that were studied and positive allelopathy on all the bean cultivars.[10]

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