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A review: Current status of niger diseases and their integrated management

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Abstract
Niger (*Guizotia abyssinica*) is a oilseed crop which plays significanrt role in the food and nutritional security of the poor tribal. It is cultivated to limited extent in Ethopia, South Africa, East Africa, West Indies and Zimbabve. India ranks first in area, production and export of Niger in the world. In India it is mainly cultivated in tribal pockets of M.P., Orissa, Maharashtra, Gujarat, Bihar, Karnatka and Andhra Pradesh. Niger is although considered as a minor oilseed, is very important in term of quality and taste of its oil and export potential. Niger is a crop of dry area grown mostly by tribal in interior places due to which desired attention has not been given on the biotic and abiotic stresses. Now the crop is gaining importance and studies are being made on disease aspects. The important diseases of Niger are Ozonium wilt (*Ozonium texanum* var. *parasiticum* Thirum.), Collar rot (*Sclerotium rolfsii* Sacc.), Macrophomina root and stem rot [*Macrophomina phaseolina* (Maubl.) Ashby], Damping off/root rot (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora guizoticola*), Alternaria blight (*Alternaria sp.),* Curvularia leaf spot (*Curvularia lunata*), Powdery mildew (Sphaerotheca sp.), Rust (*Puccinia guizotiae*), Bacterial leaf spot (*Xanthomonas campestris* pv. *guizotiae*), Seed rot/ Seed borne microorganisms and Cuscuta (*Cuscuta hyalina*). The information on important diseases of Niger and their integrated disease management (IDM) are discussed in this review.

Keywords: Niger, *Guizotia abyssinica,* integrated disease management (IDM)

Introduction
Niger [*Guizotia abyssinica* (L. f.) Cass.] Is an important minor oilseed crop grown in tropical and subtropical India, Ethopia, South Africa, East Africa, West Indies and Zimbabwe? India ranks first in area, production and export of Niger in the world. Niger though a native of tropical Africa, is wide spread and cultivated extensively in India. In India it is mainly cultivated in tribal pockets of M.P., Orissa, Maharashtra, Bihar, Karnatka and Andhra Pradesh. Niger is commonly known as *ramtil*, *jagni* or *jatangi* (Hindi), *ramtal* (Gujrati), *karale* or *khurasani* (Marathi), *uhechellu* (Kannada), *payellu* (Tamil), *verrinuvvulu* (Telugu), *alashi* (Oriya), *sarguza* (Bengali), *ramtil* (Punjabi) and *sorguja* (Assamese) in different parts of the country (Rao and Ranganatha, 1989) [13]. It is the lifeline of tribal agriculture and economy in India. It is grown by tribals on marginal and submarginal lands with negligible inputs under rainfed conditions (Ranganatha, 2009) [20]. Niger although considered a minor oilseed crop, is important in terms of its 32 to 40 per cent of quality oil with 18 to 24 per cent protein in the seed. Niger is a neglected minor oilseed crop of India, which plays an important role in the food and nutritional security of the poor tribal segment of Indian population. Niger is an important oilseed crop in Ethiopia where it provides about 50-60 per cent of the oil for domestic consumption (Riley and Belayneh, 1989) [14]. It is also used as an oilseed crop in India where it provides about 3 per cent of the edible oil requirement of the country (Getinet and Sharma, 1996) [4]. Niger oil is slow drying, used in food, paint, soap and as an illuminant. The oil is used in cooking as a ghee substitute. It is also used as a substitute for olive oil. The crop is capable of giving good seed yield even under low soil fertility, moisture stress and poor crop management. It has good degree of tolerance to insect pests, diseases and attack of wild animals (Ranganatha *et al*., 2014) [12]. It has good potential for soil conservation, land rehabilitation and as a biofertilizer, consequently the crop following Niger is always good. These attributes favour its cultivation on hilly areas, marginal and submarginal lands in and around the forest (Ranganatha *et al*., 2009) [11]. It has the yield potential of 800-1000 kg/ha under optimum growing conditions.

The low seed rate, capability to grow on a wide range of soils and sowing period starting from the onset of monsoon to September-October, makes this crop ideal for contingent crop under rainfed situations.
In India, Niger is grown in an area of 2.53 lakh hectares with the production of 0.83 lakh tonnes and the productivity of 326 kg./ha during 2016-17. Niger is a crop of dry areas grown mostly by tribals in interior place due to which desired attention was not accorded on the biotic and abiotic stresses. Insect pests, diseases and weeds impose a serious threat to Niger crop production (Srivastava *et al*., 2009) [20]. The crop is gaining importance and studies are being made on insect disease aspects (Rajpurohit, 2011).
Many diseases have been reported on Niger (Table 1). Of these, Niger blight (*Alternaria* sp.) and leaf spot are the most serious. Control measures for Cercospora leaf spot, powdery mildew, alternaria leaf spot, root rot and *Cuscuta hyalina* are being developed in India.

Table 1: List of Niger diseases

Pathogen	Disease	Distribution	Reference
Alternaria dauci	On seeds and leaf	Ethiopia	Stewart and Yirgu (1967)
Alternaria porri sp. *dauci*	Leaf spot	Ethiopia	Yirgu (1964) [30]
Alternaria sp.	Stem and leaf blight	Ethiopia	Yitbarek (1992) [33]
Aspergillus sp.		Ethiopia, India	Kolte (1985) [7]
Bremia lactucae	Downy mildew	Ethiopia	Stewart and Yirgu (1967)
Cercospora guizoticola	Leaf spot	Ethiopia, India	Yirgu (1964) [30]
Cladosporium sp.		Ethiopia, India	Yirgu (1964) [30]
Emericella sp.		Ethiopia India	Kolte (1985) [7]
Fusarium sp.		Ethiopia, India	Kolte (1985) [7]
Ozonium taxanum var. *parasiticum*	Ozonium wilt	India	Kolte (1985) [7]
Macrophomina phaseolina		Ethiopia, India	Chivan (1961) [3], Yirgu (1964) [30]
Phoma sp.	Stem lesion, wilting	Ethiopia	Yitbarek (1992) [33]
Phyllosticta spp.	Tar spot	Ethiopia, India	Yirgu (1964) [30]
Plasmopara halstedii	Downy mildew	Ethiopia	Yitbarek (1992) [33]
Puccinia guizotiae	Rust	Ethiopia	Yirgu (1964) [30]
Rhizoctonia solani	Root rot	Ethiopia	Yirgu (1964) [30]
Rhizoctonia bataticola	Seed rot	India	Yitbarek (1992) [33]
Sclerotium rolfsii	Seed rot	India	Kolte (1985) [7]
Sphaerotheca sp.	Powdery mildew	India	Yirgu (1964) [30]
Xanthomonas campestris pv. *guizotiae*	Leaf spot	Ethiopia	Yirgu (1964) [30]
Anguina amsinckia	Leaf gall	Ethiopia	Stewart and Yirgu(1967)
Epicoccum nigrum		Ethiopia	Yirgu (1964) [30]
Erysiphe cichoraceurum		Ethiopia	Yirgu (1964) [30]
Coniothyrium sp.		Ethiopia, India	Kolte (1985) [7]
Penicillium spp.		Ethiopia, India	Yirgu (1964) [30]
Xanthomonas campestris pv. *guizota* var. *indicus*		India	Kolte (1985) [7]
Septoria sp.		Ethiopia	Stewart and Yirgu(1967)

Important diseases of Niger and their integrated management

Niger is a crop of low rainfall areas grown mostly by tribals in remote places due to which no attempt has been made to assess or survey the diseases of this crop. Now the crop is gaining importance and studies are being made on disease aspects. Integrated disease management is one such major step towards sustainable production of Niger crop. The IDM programme is a combination of cultural, chemical and biological methods including resistant varieties which is more effective and ecofriendly and sustainable. The common diseases observed on Niger and their integrated management are discussed in this review.

Ozonium wilt (*Ozonium texanum* var. *parasiticum* Thirum.)

The disease was reported around Varanasi where it appeared in great severity (Saharan, 1989) [17]. Heavy losses are incurred as the diseased plants dry. Necrotic lesions develop on stem of well grown plants near the soil level, which gradually extends upwords. Whitish fungal mycelium grows on these necrotic areas under high humidity and the branches, leaves, inflorescence etc become soft and start rotting. The diseased stem, breaks. It is caused by fungus *Ozonium texanum* var. *parasiticum* Thirum (Thirumulachar, 1951) [26]. The mycelium grows on dead plants if enough moisture is present. Root rot is also commonly observed. The fungus forms rhizomorphs and sclerotia. The sclerotia are oval, grey to dark brown. The recurrence takes place through soil borne sclerotia and mycelium. Treating the seed with Thiram at the rate of 2 g/kg seed before sowing is quite effective to control the disease (Saharan *et al*., 2005) [15].

Collar rot (*Sclerotium rolfsii* Sacc.)

The disease was first reported from Dharwad Karnataka (Siddarmaih *et al.* 1979) [22]. The tissues of collar region become soft and depressed. White fungus grows on the diseased part and forms mustard seed like sclerotia. The diseased plants turn yellow and dry and caused by the fungus *Sclerotium rolfsii* Sacc. The disease is soil borne. As the plant number is reduced, the disease causes yield losses.

Macrophomina root and stem rot [*Macrophomina phaseolina* (Maubl.) Ashby]

The imperfect stage of the fungus is *Rhizoctonia bataticola*. It is seed and soil borne. Typical root rot, stem rot, charcoal rot and leaf blight symptoms are produced**.** *Macrophomina* infected roots are light blackish to black in colour, which are covered with black sclerotia and are brittle. The blackening extends from ground level upward on the stem giving black colour to stem. The recurrence of the disease takes place through seed and soil borne inoculum, later spread is through workers, tools and insects**.** Deep ploughing in summer, crop rotation, seed treatment with thiram (0.2%) + Carbendazim (0.1%), application of *Trichoderma viride* @ 2.5 kg/ha mixing with 50 kg FYM in the field before sowing can effectively manage the disease.

Damping off/root rot (*Rhizoctonia solani*)

The fungus attacks stem of the seedling at ground level, makes water soaked soft and incapable of supporting the seedling which falls over and dies. On older seedlings elongated brownish black lesions appear which increase in length and width girdling the stem often the roots are clackened due to fungal attack resulting in root rot. The disease is favoured by cold and wet weather. The seed should be treated with Thiram or Captan @3.0 g/kg seed (Sharma, 1982) [18]. The disease can also be reduced by drenching the plants with Captan 50 WP @0.25% and crop rotation should be followed.

Cercospora leaf spot (*Cercospora guizoticola*)

Cercospora disease is prevalent in all the Niger growing areas and causes yield reduction. The disease is severe under warm and humid weather (Rajpurohit, 2011). Disease appears as small straw to brown coloured spots with grey centre on the leaves, spots may coalesce causing defoliation. 'Later the spots increase in number and size and cover the entire lamina and the leaves start dropping off. Elongated dark brown spots are produced on the stem. The capsules are also affected. The pathogen is seed and soil borne. The primary infection occurs through seed borne inoculum as well as the inoculum present on diseased plant left over in the soil. The spread of the disease is through conidia formed on infected plant parts. The fungus is active throughout the year where Niger is grown in *Rabi* and *kharif seasons.* The pathogen remains active on other collateral hosts also. Seed treatment with two foliar sprays of Carbendazim 50WP (0.2%) + Mancozeb (0.1%) can manage the disease (Gupta, 2017) [5].

Alternaria leaf spot/blight (*Alternaria sp.)*

Alternaria sp. has also been reported from India. *Altenaria* blight of Niger is more serious in Ethiopia as compared to India. The disease appears as concentric rings on the leaves, which turns brown with grey centre later on. As the disease advances, the spots become oval or circular and irregular in shape. The infected leaves become dry and lead to the defoliation. Further it, spreads to other plant parts and results in to premature drying of the plant (Yirgu, 1964a) [31]. The pathogen is seed and soil borne. Use of resistant varieties like JNC-6, IGP-76, Deomali, GA-11, ONS-8 (Hegde, 2005) [6], seed treatment with thiram (0.2%) + carbendazim 50WP (0.1%) and spray with mancozeb (0.25%) + carbendazim 50WP (0.1%) at 15 days interval, two sprays with zineb or dithane M-45 (0.3%), spraying mancozeb (0.2%) at 15 days interval as the disease starts appearing can effectively manage the disease (Saharan *et al.,* 2005) [16]. Seed treatment and spraying of Carbendazim 50WP (0.2%) + mancozeb (0.1%) at 15 days interval as the disease starts appearing can effectively manage the disease (Gupta, 2017) [5]. Two sprays with Zineb or Dithane M-45 at the rate of 0.3 per cent as the disease starts appearing can effectively manage the disease [Saharan et al., 2005] [15]. Spraying Mancozeb @ 0.2% at 15 days interval reported effective [Hegde, 2005] [6]. Use of resistant varieties like JNC-6, 1GP-76, Deomali, GA-11, ONS-8 (Hegde, 2005 and Rajpurohit *et al.*, 2005) [6, 10]

Curvularia leaf spot (*Curvularia lunata*)

Small circular to irregular brown to reddish brown spots which later coalesce to form larger spots. The leaf turn yellow dries and defoliates. The pathogen is seed borne and survives in plant debris

Powdery mildew (*Sphaerotheca* spp.)

The powdery mildew is caused by *Sphaerotheca* sp. in Ethiopia (Chavan, 1961) [3], whereas, it is known to be caused by *Oidium* sp. (*Erysiphe cichoracearum* DC) in India as reported by Vasudeva, 1954. It is major problem in Niger where ever it is grown. The disease occurs in *Rabi* as well *as kharif* season but it is more severe in *Rabi*. The yield loses are due to early defoliation as a result of the disease. All the aerial parts develop symptoms. Small cottony spot develops on the leaves which gradually cover the whole lamina (Vyas *et al*., 1981). Some times on stem a purple rings also develops. The diseased leaves turn yellow and drop off. The seed formed on diseased plants are small and shriveled. The pathogen is known to survive through some unknown collateral hosts. The disease can be managed by burning the infected plant parts after the harvesting of the crop. The disease can also be effectively controlled by spraying with sulfex at the rate of 0.3 per cent as the disease starts appearing. Another spray can be done after 10-15 days intervals depending upon the disease intensity. Foliar spray of wettable sulphur (0.2%) or carbendazim (0.1%) or karathane (0.1%) reported effective against the disease (Sharma, 1982, 1989) [18, 19].

Rust (*Puccinia guizotiae*)

Rust was first reported from Ethiopia (Yirgu, 1964a] [31]. The disease is more severe in Ethiopia as compared to India. It is caused by *Puccinia guizotiae.* Brown pustules up to 7 mm in diameter appear on the leaves. The lesions consist of densely aggregated brown telio that measure 0.16 to 0.37 mm in diameter. The uredosori are formed on the lower leaf surface and the corresponding upper surface becomes chlorotic. Later teliospores are formed. The teliospore measures 37-49 x16-20 um in size (Kolte, 1985) [7]. The disease can be managed by spraying crop with Dithane M- 45 as the disease starts appearing.

Bacterial leaf spot (*Xanthomonas campestris* pv. *guizotiae*)

Bacterial leaf spot is caused by two pathogens viz. *Xanthomonas campestris* pv. *Guizotiae* which is severe in Ethiopia whereas in India it is incited by *X campestris* pv. *Guizotiae* var. *indicus.* This disease was first reported from Ethiopia (Yigru, 1964b). Small brownish spots are formed on leaves which are surrounded by yellow halo. Most of the spots are on mainly on the leaf margin. The spots increase, coalesce and give appearance of blight. All the leaves get destroyed. Under severe cases, scabby brown needle pricks lesion produced around needle pricks on the stem (Yigru, 1964a). The bacterium *X. campestris* pv. *Guizotiae* var. *indicus* also produces similar type of the symptoms on the plants but the bacterium requires low temperature for growth and infection (Moniz *et al*., 1968) [9]. The disease can be managed by spraying the crop with Blitox-50 at the rate of 0.2 per cent (Saharan *et al*., 2005) [16].

Seed rot/ Seed borne microorganisms
Several fungi have been reported seed borne like *Alternaria sp., Aspergillus flavus, A. Niger, Rhizopus nigracans, Cercospora guizoticola, M. phaseolina, R. batalicola* etc. (Siddarmaiah *et al*., 1980a, Siddarmaiah *et al*., 1980b) [21, 23]. Besides fungi bacteria like *Xanthomonas campestris* and Actinomycetes have also been reported to be associated with rotting of the seeds (Kulkarni and Oblisami, 1973) [8].

Cuscuta (*Cuscuta hyalina*)
Dodder a parasitic weed is the major menace of Niger in some parts of the country like Odisha, Andhra Pradesh and parts of Madhya Pradesh (Tosh *et al*., 1977) [27]. The plants remain stunted, pale yellow and bear a very small number of flowers and fruits due to the association of *Cuscuta.* It is a total stem parasite depending for shelter and food totally on the host. The food is obtained through haustoria's from the host usually the Cuscuta seed gets mixed with Niger seed and such mixtures are planted. The Cuscuta seeds can be removed by sieving before sowing. Removal of cuscuta infected Niger seed at the early crop growth. Application of thiobencarb at 0.75 kg/ha and anilofos at 0.50 kg/ha significantly reduced the weed dry matter and increased the seed yield of Niger. When this herbicides were integrated with hand weeding at 30 or 45 DAS, seed yield were substantially increased. Pre-emergence application of oxadiazon @ 0.75 kg/ha, pendimethalin @ 1.0 kg/ha and alachlor@ 1.0 kg/ha was found effective in controlling weeds and increasing seed yield. Pre sowing application of fluchloralin @ 1 kg a.i./ha or pre emergence soil application of pendimethelin @ 1-1.25 kg a.i. /ha (Hegde, 2005) [6] sieving by separation of cuscuta seeds by 1 mm sieve + 10% brine solution seed treatment (Anonymous, 2009) [1].

Resistance to diseases: Development of varieties resistant to diseases is also an important aspect. So far there is not much work carried out on this aspect. However, the efforts in this direction are needed for development of resistant varieties. During the evolutionary process, Niger has evolved more for survival, fitness and tolerance to stresses rather than for high seed yield. The crop is mainly grown under marginal and submarginal conditions with poor management and also subjected to vagaries of nature, which adversely affect the crop yield. However, Niger survives over a wide range of conditions and adjusts with change that may occur in its surroundings due to various kinds of stresses. Different promising lines have been identified (Rajpurohit *et al*., 2005, Anonymous, 2015) [10, 2], which may be utilized in resistance breeding programme for the development of tolerant lines against diseases of Niger

Table 2: Tolerant lines identified for different diseases

Disease	Tolerant lines
Cercospora leaf spot	JN-13, JN-106, JN-107, JN-112, JN-118, JN-128, JN-130, JNS-9, PCU-45, PCU-46, N-24, N-128, AJSR-48, ONS-157
Alternaria leaf spot	RCR-328, JN-121, N-17, N-18, N-24, N-87, N-128, N-141, N-142, N-165, N-187, AJSR-47, AJSR-48
Powdery mildew	KEC-6, RCR-238, RCR-290, JN-17, JN-19, JN-20, JN-21, JN-37, JN-60, JN-68, JN-72, JN-77, JN-78, JN-85, JN-86, JN-87

Biotechnological approaches for Niger diseases
Niger is attacked by a number of fungal diseases. As modern high yielding, genetically uniform cultivars are used, threats from disease will increase which will require increased emphasis on resistance breeding wild species of the genum *Guizotia* could serve as source for disease resistance genus which could be intogressed into the cultivated species. During the last few years modern techniques of plant tissue culture, double haploid technology and transformation are increasingly used by breeders. Protocol to regenerate plants from Niger hypocotyls and cotyledon tissue and seedlings were developed. Plant regeneration was dependent on genotypes and media composition. If Niger is susceptible to *Agrobacterium tumefaciens* infection, then it will be good for gene transfer. Dihaploid plants of Niger have been produced by another culture self-compatible lines, dwarf and single transfer diahaploids plants of Niger have been produced by another culture. Self-compatible lines, dwarf and single headed double haploid plants were obtained from another culture. Anther and microspore derived diahaploid can be used to develop homozygous inbred lines is a short time. Recessive simply inherited and easily identifiable marker traits which are important for Niger seed production to ensure genetic purity of varieties could be obtained through microspore culture technology.

Impact Assessment
The AICRP has contributed to the development of technologies across different agro ecological situations. The demonstration of these technologies under real farm situations is done through frontline demonstrations. The productivity of Niger is low, around 300 to 350 kg/ha in India. Niger productivity has increased by 86 per cent during 2012-13 and production by 10 per cent even after a reduction of 41 per cent in the area over 1965-66 (Ranganatha *et al*., 2014) [12]. Can be obtained in a single generation by another culture. These fertile homozygous plants can be used for selection of desirable recombinants. In highly heterozygous cross pollinating crops, haploidy creates a rapid method of producing pure lines which can serve as parents in hybrid development. Because homozygous lines can be generated rapidly; a saving of time up to 50 per cent can be achieved in developing new cultivars. Simmonds and Keller (1986) identified a number of factors, which influence embryo/ callus formation from gameotophytic cell and they are donor plant physiology, developmental stage of gametophytic cells, pretreatment of gametophytic cells, culture medium composition, physical factors, culture environment and donor genotype. The micro propagation method also has potential application for Niger breeding, cell selection for desirable mutants and genetic transformation.

Future Perspective
Production and supply of good quality seeds of improved varieties (tolerance to Alternaria leaf spot/blight) in adequate quantities should be ensured for stability and higher productivity. Characterization and evaluation of germplasm should be standardized and descriptors should be developed. Since Niger has an allelopathic and mycorrhizal association, it will be interesting to identify the substance associated with the weed suppression effect. Identification of the resistant sources, seed treatment and other plant protection techniques conductive for IDM/IPM on the basis of forecasting of pest and disease in different agro ecological situations need to be popularized. Low cost production technologies for small and marginal farmers should be developed. District contingency plans should be prepared for capitalizing the full potential of available opportunities and made available to the extension agencies. Adoption of preharvest and postharvest technologies at farm level should be encouraged to reduce the

losses and improve the quality. To optimize the use of resources to reduce the risk, remunerative cropping systems should be developed for different agro ecological situations by integrating the improved nutrient, and disease management practices.

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