J. Phytol. Res. **30** (1) : 31-45, 2017 **ISSN 0970-5767**

SEED-BORNE AND POST-HARVEST DISEASES OF CASTOR BEAN (*RICINUS COMMUNIS* LINN.) AND THEIR MANAGEMENT: A REVIEW

D. K. SHARMA* and SHAFKAT RANA
*Department of science and technology, Vardhaman Mahaveer Open Universiy, Kota, Rajasthan, India
Department of Botany, Shri Govind Guru Govt. PG College Banswara, Rajasthan, India.
*Corresponding author : E-mail: drdilipsharma12@gmail.com

Castor bean (*Ricinus communis* L.) of family Euphorbiaceae is indigenous to eastern Africa and most probably originated in Ethiopia. It is widely distributed throughout the tropics, sub-tropics and temperate regions of the world. India is largest producer in the world and contributes 55-60 per cent of global production. The plant has several bioactive compounds or secondary metabolites that having medicinal and antimicrobial properties. In India, it has been documented since 2000 BC for lighting lamps and in local medicine. It is used as laxative, purgative and cathartic in Unani, Ayurvedic and other ethnomedical systems. The yield of crop reduced due to attack of several pathogens like fungi, bacteria, virus, mycoplasma and nematode diseases throughout the world which causes severe losses, reduces plating and market value of the crop. The main diseases are root rot, gray rot, seedling blight, alternaria blight, leaf blight, brown leaf spot, cotton rot, grey mold; inflorescence and stem rot, fruit rot, charcoal rot, wilt, leaf rust, powdery mildew, bacterial blight and leaf spot.

Keywords: Disease management; Seed-borne diseases; Seed-borne pathogen.

Introduction

Castor bean (*Ricinus communis* L.) of Euphorbiaceae is an important non-edible oil seed crops indigenous of eastern Africa and most probably originated in Ethiopia. The plant is widely distributed universally mainly in India, China, Eastern Africa, Ethiopia and Brazil[1]. India occupies about 57 per cent of the world castor acreage with 62% production of the world. In India, major castor growing states are Gujarat, Andhra Pradesh, Rajasthan, Tamil Nadu and Orissa. India is largest producer of castor seed in the world and contributes 55-60 per cent of total global production. In India, castor is grown in area of 12.33 lakh ha with 19.64 lakh t average productivity of 1592 kg ha-1 during 2012-13. Gujarat is largest producer of castor seed with production of 14.93 lakh t followed by Rajasthan (3.41 lakh t) and Andhra Pradesh (1.05 lakh t) in 2012-13[2]. In Rajasthan, it is grow in districts as Jalore, Sirohi, Barmer, Jodhpur, Hanumangarh, Pali and Sriganganagar[3]. The plant is reported to possess anti-oxidant, anti-implantation, anti-inflammatory, anti-diabetic, anti-tumor, larvicidal, anti-nociceptive and anti- asthmatic

due to the occurrence of important phytochemical constituents like flavonoids, glycosides, alkaloids, steroids etc. Castor seeds have 50–55% non-edible oil which contains steroids, saponins, alkaloids, flavonoids and glycosides[4-7] The dried leaves have two alkaloids as ricinine (0.55%) and N-demethylricinine (0.016%); six flavones glycosides namely kaempferol-3-O-β-D-xylopyranoside, kaempferol-3-O-β-D-glucopyranoside, quercetin-3- O-β- D-xylopyranoside, quercetine-3-O-ß-glucopyranoside, kaempferol-3-O-β-rutinoside and quercetin-3-O-β-rutinoside. The monoterpenoids (1, 8-cineole, camphor and α-pinene) and a sesquiterpenoid (β-caryophyllene), gallic acid, quercetin, gentisic acid, rutin, epicatechin and elingic acid are major phenolic compound isolated from leaves. Root extract contains Indole-3-acetic acid. The seeds contain 45% of fixed oil, consists glycosides of ricinoleic acid, isoricinoleic, stearic and dihydroxystearic acids, lipases and a crystalline alkaloid and ricinine[8, 9]. The fatty acid composition of the oil by gas chromatography-mass spectrometry (GC-MS) showed ricinoleic acid (74.10%) as the major constituent fatty acid. Other fatty acids are linoleic (10.32%), oleic (7.55%), stearic (2.81%), palmitic (2.59%), erucic (1.70%) and eicosadienoic (0.93%)[10].

The plant of castor bean is a small tree of which most of parts are of important uses *viz*. root bark, leaves and flowers. Traditionally the plant is used as laxative, purgative, as fertilizer and having antimicrobial properties[11-14]. Castor oil is used in the manufacture of wide range of industrial products such as nylon, fibers, jet engine lubricants, hydraulic fluids, dyes, detergents, soaps, ointments, greases, paints, varnishes, cosmetics and perfumes etc[15]. Castor is attacked by several pathogens like fungi, bacteria, virus, mycoplasma and nematode diseases throughout the world causing severe losses, quality of seeds and market value of seeds[16-18].

The fungal diseases are root rot, gray rot, seedling blight, bacterial blight, alternaria blight etc. In India, yield loss of 80–100% has been attributed to fungal diseases[19] and this has affected the income of farmers in terms of foreign exchange. Many *in vitro* studies have demonstrated that some fungicides restrict or prevent the growth of fungal pathogens[20-22]. The important diseases of castor bean are Phytophthora seedling blight, Rust, Alternaria leaf spot, Cercospora leaf spot, Anthracnose, Powdery Mildew, Stem rot, Fusarium wilt, Bacterial leaf spot, Bacterial wilt or Slime disease, Tobacco ring spot, Tobacco necrosis and cucumber mosaic virus[23].

The important seeed-borne diseases are Leaf blight disease caused by *Alternaria ricini* (Yoshu) Hansag reported from various states as Kanpur, UP, Maharashtra[24], Gwalior, M.P.[25], Ajmer, Rajasthan[26-28], spot on leaf and in seed caused by *Alternaria tenuis* Nees (= *A. alternata* (Fr.) Keissler)[28], *Alternenaria tenuissima* (Kze. ex Pers.) Widt. Jabalpur, M.P.[29], *Cercospra ricinella* Sacc & Berl Pusa, Muzaffarpur, Bihar[30,31], Hyderabad, Andhra Pradesh[32], Kokilamukh, Assam[33], *Corynespora cassicola* (Berk. & curt.) Wei Hydrabad, Andhra Pardesh[34], *Leptosphaerulina ricini* Karan Hyderabad, Andhra Pradesh[35], *Phyllosticta bosensis* Bose & Mathur Kanpur, U.P.[36], *Periconia byssoides* Pers. ex Schw Hyderabad, Andhra Pradesh[34]; spot on stem caused by *Botryodiplodia ricinicola* (Sacc.) Petrak (=*B. theobromae* Pat.) Pusa, Bihar, Bellary Tamil Nadu[37,38], Inflorescence and stem rot caused by *Botryodiplodia ricini* (Godfrey) Whetzel (= *Sclerotinia ricinus* Godfrey)

Banglore, Karnataka[39], wet rot caused by *Choanephora cucubitarum* (Berk. & Rav.) Thaxt. Gorakhur, U.P.[40]; fruit rot caused by *Cladosporium oxysporum* Berk. & Curt Ludhiana, Punjab [41]; twig blight caused by *Glomerella cingulata* (Stonem.) Spauld. & Schrenk, Dharwar, Karnataka[42]; root and stem rot caused by *Macrophomina phaseolina* (Tassi) Goid Nadiad, Gujrat[43]; leaf rust caused by *Melampsora ricini* (Biv Bern.) Passerini Poona, Nagpour, Maharastra; Coimbatore, Tamil Nadu [44,45] Hyderabad, Andhra Pradesh[43,46]; powdery mildew caused by *Oidiopsis taurica* (Lev.) Salmon (conidial state of *Leveillua taruica* (Lev.) Arnaud.) Coimbatore, Tamil Nadu[47-48]; fruit rot caused by *Phytophthora colocasiae* Racib. emend. Thomas & Ramakr. T.S. Poona, Maharashtra[49,50]; root and seed rot caused by *Phytophthora parasitica* Dast Muzaffarpur, Bihar[31], *Pythium aphanidermatum* (Eds.) Fitz.[51-54]; root rot caused by *Pythium debaryanum* Hesse[54-56]; on seeds in storage caused by *Pythium proliferum* de Bary:, Pusa, Bihar[52,54,57]; spot on leaf, petioles and young shoots caused by *Sphaceloma ricini* Jenkins & Cheo, Chinchwad, Maharashtra[58], Phyllody from South India[59]. Bacterial blight and leaf spot caused by *Xanthomonas ricini* (Yoshi & Takimoto) Dowson is a very common in Andhra Pradesh; Tamil Nadu; Rajasthan; Gujarat; Bombay and Delhi[60].

Sahran(2005)[61] reported some minor diseases *viz.* anthracnose caused by *Colletotrichum capsici*[62], Bacterial Leaf spot caused by *Pseudomonas syringae* [63], Bacterial wilt caused by *Ralstonia solanacearum* [64,65], Collar rot caused by *Sclerotium rolfsii*[66]; Damping- off caused by *Pythium aphanidermatum*[67]; Die- Back caused by *Botryosphaeria quercuum*[68]; Fruit rot caused by *Phytophthora colacasiae*; Leaf blight caused by *Phytophthora palmivora, Phytophthora nicotainae* var. *parasitica*[125,126], Leaf spots caused by *Cercospora ricinella, Phyllosticta bosensis, Cladosporium* sp., *Diplidia ricinicola, Cercospora coffeicola, Alternaria tenuissima, Leptosphaerulina ricini, Periconia byssoides, Corynespora cassicola, Cochliobolus lanatus, Sclerotinia sclerotiorum, Sphaceloma ricini, Botryodiplodia ricinicola, Myrithemcium roridum* [29,34,41,58,67,127-130], Powdery mildew caused by *Laveillula taurica*[67], Rust caused by *Melampsora taurica*[67], Sclerotinia rot caused by *Botryotinia ricini*[67], Seed rot caused by *Cephalosporium curtipes*[67], Stem canker caused by *Botryosphaeria dothidia*[68], Stem rot caused by *Physalospora ventricosa, Phytophthora nicotianae* [131,68], Twig blight caused by *Glomerella cingulata*[42], Twig rot caused by *Diaportthe arctii*[132] and Verticillium wilt caused by *Verticillium alboatrum* [133]. A number of fungal species have been reported from Pakistan on castor bean viz. *Alternaria* sp., *Aspergillus* sp., *Curvularia* sp., *Fusarium* sp., *Helminthosporium* sp., *Mucor* sp., *Nigrospora* sp., *Penicillium* sp., *Sclerotium* sp. and *Thielavia* sp.[134]. The damaging pests are those attack on inflorescence such as mirids (*Helopeltis* spp.), peach moth (*Conogethes punctiferalis*) in India and throughout south-East Asia[81].

In a study, 10 endophytic fungal species isolated from *Ricinus communis* namely *Aspergillus fumigates, Aspergillus japonicas, Aspergillus niger, Fusarium semitectum, Curvularia pallescens, Phoma hedericola, Alternaria tenuissima, Fusarium solani, Drechslera australien* and *Aspergillus repens*[79,135].

Thirty one fungal species belonging to 15 genera were isolated from 12 samples of castor bean seeds collected from different areas of Pakistan and *Fusarium solani,*

Alternaria alternata, Cephaliophora tropica were found most predominant including saprophytic fungi as *A. niger* and *A. flavus*. Blotter method was considered to be better technique which gave maximum number of fungi followed by agar plate and deep freezing methods[136].

Nagaraja *et al*. (2009)[75] isolated 47 fungal species belonging to 7 genera from 185 samples of castor bean seeds. *F. oxysporum, Alternaria ricini, A. alternata, Culvularia lunata, Macrophomina phaseolina, Sclerotinia sclerotium, Cladosporium herbarum, Chaetomium globosum, Botryodiplodia acerina, Stachybotrys chartarum, Aspergillus ochraceus, A. niger, A. flavus, A. versicolor* and *Rhizopus stolonifer* were found predominant fungal species on castor seeds.

Fungi associated with the fruits and seeds of some *Jatropha* species and *Ricinus communis* were investigated in Benin City. The isolation and subculture of isolates on Potato Dextrose Agar (PDA) were identified as *Fusarium* and *Cornularia spp*. from *Ricinus communis* [69].

In a study the seeds of castor bean from China were obtained and fungal species isolated and identified as *Aspergillus flavus* Link ex Gray (56%), *Aspergillus niger* Van Themghn (48%), *Aspergillus tereus* Thom (40%), *Penicilium* sp. Link ex Fr (35%), *Fusarium oxysporum* Schlecht Emend. Sny. & Hans (30%), *Rhizopus stolonifer* (Erenb.ex Link) Lind (25%), *Curvularia lunata* (Wakker) Boedijn (25%) and *Botrytis cinerea* Pers.ex Nocca & Balb (20%). These fungal species controlled by neem leaf extracts of varying concentrations on the *in-vitro* growth isolates showed significant reduction ($P \leq 0.05$) at different concentrations. It is recommended that neem is effective, cheap and ecofriendly in the control of seed-borne mycoflora of castor bean[70].

In Karnataka, it was reported that plant is affected by number of fungal diseases as wilt (*Fusarium oxysporum* f.sp. *ricini*), leaf spot and blight (*Alternaria ricini*), cercospora leaf spot (*Cercospora ricinella*), root rot, stem rot and charcoal rot (*Macrophomina phaseolina*), seedling blight (*Phytophthora parasitica*), capsule rot (*Cladosporium oxysporum*), fruit rot and Gray rot (*Botrytis ricini*), rust (*Melamspora ricini*), powdery mildew (*Leveillula taurica*), phyllosticta leaf spot (*Phyllosticta bosensis*), angular leaf spot (*Botrytis* sp.), and damping off (*Phythium aphanidermatum)*[71-77] . These diseases reduces the yield, production and germination up to 30-50% [34,78,79].

Four types of methods used to detect *Alternaria ricini* and it was found that standard blotter method was more sensitive in detection of *A. ricini* than the PDA, water agar and 2, 4, Dichloro phenoxy acetic acid medium. Total nine fungal species namely *Alternaria ricini, F. oxysporum* f.sp. *ricini, A. alternata, Cercospora ricini, Macrophomina phaseolina, Chaetomium globosum, Aspergillus flavus, A. niger* and *A. ochraceus* were isolated and detected from local variety of castor beans. Out of nine fungal species *A. ricini* was found predominant in the seed samples sixteen districts (16.8%)[76].

A seed-borne fungi *Fusarium oxysporum* f. sp. *ricini* and its pathogenicity were studied from Karnataka by using different seed health testing methods and out of 69 10 samples show higher incidence of pathogen on various methods. The pathogen showed the symptoms of wilts were observed in 1-10 percent wilts in one, 10-30 percent in two month seedlings and 30-60 percent wilts in three month old plants, no

wilts observed in water treatment plants[71,72,77].

The bacterial disease of castor in Sudan has been reinvestigated. Typically the disease symptoms are brown or black, round or angular lesions on leaves; occasionally the thin succulent branches are attacked, but not the vascular tissue. The bacterium responsible for the disease was previously thought to be *Pseudomonas solanacearum* but comparative studies show that the Sudan species differs in pathogenicity and physiology from *P. solanacearum.* It closely resembles *Xanthomonas ricinicola* (Elliott) Dowson (=*Bacterium ricini* Yoshi and Takimoto) in characters, host range and pathogenic effects. In culture on solid media the growth of *X. ricinicola* is typically yellow, while that of the Sudan species is dirty white; but this difference is not considered sufficient to justify the establishment of a new species[79].

(i) MAJOR DISEASES OF CASTOR BEAN

Seed rot and seedling blights- Seedling blight disease was reported in Uttar Pradesh and Hyderabad [80,81]. In wet soil after germination seedlings are susceptible to a number of roots and stem rot organisms. The most common fungal species which attack are species of *Fusarium, Rhizoctonia, Sclerotium* and *Phytophthora. P. parasitica* Dastur (syn. *P. nicotianae* Breda de Haan) is a typical root rot pathogen have wide range of host and capable to infecting over 72 plant genera [82,83]. It is common disease of castor in India which was first reported from Pusa, Bihar. Initial stage of plant growth in moderate to severe form with seedling mortality was 30 to 40%. Root rot disease has been reported from Philippines, India, Ceylon, East Africa, Palestine, West Indiesand eastern United states [84]. In India, it is reported from Andhra Pradesh, Gujarat, Maharashtra, Bihar and Tamil Nadu [80,85,86,90,91].

The seedling blight disease has been reported from Argentina, Brazil, Bulgaria, China, Malaya and Sumatra[87-89]. The root rot disease is favoured by ill drained and prolonged rainy season[90]. In disease stunting accompanied by a black rot in the tap root and elongated, brown lesions on the hypocotyl was caused by *Thielaviopsis basicola*.

Seed treatment was given, independently to castor seeds with three *Trichoderma asperellum* strains (TaDOR-N13, -TV5, -7316) and one *T. harzianum* strain (Th4d) to cause the disease. When compared with untreated seedlings disease severity was reduced by 85.7% in Th4d-treated seedlings. TaDOR-7316 and -N13 showed 50% and 42.9% of disease reduction, respectively as compared to check [92].

The diseases can be control by removal and destroy infected plant, alternate hosts and their residues, avoid low-lying and ill drained fields for sowing or treat the seeds with thiram or captan at 4g/kg before sowing. Fungicide seed treatment is recommended in areas where seedbed temperatures may be lowered after planting[93].

Leaf blight or Alternaria Blight-The disease caused by *Alternaria ricini* (Yoshii) Hansford in castor showed symptoms on leaves, stem, inflorescences and capsules. The disease has been reported from different areas of the country [24, 27, 91, 94-98]. The blight disease is prevalent in Bulgaria, Brunei, Egypt, India, Jamaica, Nigeria, South Africa, Sudan, Tazania, Yugoslavia, United States Mississippi [24, 89, 99, 100]. Yield losses due to disease reported

up to 35% in Baker 296 variety in Texas (USA)[97]. In humid years due to extensive fructification of the fungus on capsule of castor plant giving black sooty appearance with black clouds of conidia [96].

It is reported about 70 per cent of the plants affected with the disease causing serious losses in yield and oil-content[81]. In moist condition the conidia are produced abundantly on the diseased portions produce symptoms both externally and internally [24, 96, 101]. The diseases grow in high humidity (85-90 %) and low temperature (16-20°C).

The pathogen survives on alternate hosts like *Jatropha pandurifolia* and *Bridelia hamiltoniana.* The diseases management can be done by treat the seeds with captan or thiram at 2g/kg, remove the reservoir hosts, plant debris periodically and spray mancozeb at 2kg/ha[102-104].

Brown leaf spot disease- It is identified as with minute brown specks surrounded by halo caused by *Cercospora ricinella* and *Alternaria recini*. The spots coalese form large brown patches restricted by leaf venations. Infected tissues often drop off leaving shot-hole symptoms[93]. The diseases can be control by spraying 1% Bordeaux mixture or Copper oxy chloride @ 0.2% but where the cultures of Eri-silk worm are maintained on castor plants, spraying would not be desirable. Use of resistant varieties, spraying twice with Mancozeb 2g/lit or Carbendazim 500g/ha at 10-15 day interval or treat the seed with thiram or Captan 2gm/kg seed are another control measures[103,105].

Phyllosticta leaf spot- It was reported by[36] from Kanpur (Uttar Pradesh) caused by *Phyllostlcta bosansis*. The diseases spread profusely in rainy season and appears as minute dot-like light brown spots scattered of the leaf which latter enlarge and transform into high brown circular lesions[36]. Within 10-16 days these spots attain the maximum size but they never cross the main veinlets[81].

Powdery mildew diseases- The disease is caused by *Leveillula taurica* (Lev.) Arn characterized by typical mildew growth confined to the lower surface of lamina of leaf but in infection is severe the upper surface is also covered[81]. In India, the disease was first recorded by Ramakrishnan and Narasimhalu (1941)[48] and reported to be prevalent from November to March at Coimbatore (Tamil Nadu). Light green patches under leaf surface are visible on the upper side especially when the leaves are held against light. The pathogen is endophytic and hyphae found intercellular in parenchyma of leaf. The diseases can be control by comparatively dry spray (twice) with wettable Sulphur 2g/lit at 15 days interval which is starting from 3 months after sowing. Spray of 1ml hexaconazole or 2ml dinocap / litre of water at fortnight intervals and use of resistant variety, removal of plant debris and infected plants [102,105].

Charcoal rot or stem rot disease- It is one of the most important diseases occur worldwide caused *Macrophomina phaseolina* by of castor growing regions. In Northeastern (Brazil), the disease was concentrates 65% of the country's production. The pathogenicity and aggressiveness of the charcoal rot pathogen was assessed in 27 isolates of *M. phaseolina* obtained from 6 plant species namely *Ricinus communis* (n=21), *Gossypium hirsutum* (n=2), *Sesamum indicum* (n=1), *Helianthus annuus* (n=1), *Jatropha gossypifolia* (n=1) and *Arachis hypogaea* (n=1)[106]. Stem rot is identified by symptoms such as small brown depressed lesions on and around nodes. Plant showed symptoms like wilting as drought and drooping of

leaves [93,102-104].

The diseases may be control by growing tolerant and resistant varieties like Jyothi, Jwala, GCH-4, DCH-30 and SHB-145, field sanitation, stop water logging, removal and destruction of crop debris. The selection of healthy seed or treat the seed with thiram @ 2g/kg or carbendazim at 2g/ kg seed or seed treated with *Trichoderma viride* formulation at 4g/kg of seed or soil drenching with Carbendazim (1g/1 litre of water) 2-3 times at 15 days interval, hot water treatment of seed at 58°C to 60°C for ten minutes, spray of Copper oxychloride 2kg/ha or Streptocycline 100g/ha or Paushamycin 250g/ha are some important control measures [93,102,103,105].

Wilt disease- It is caused by various species of *Fusarium* and it was first time reported in morocco[107]. Occurrence of wilt from Krasnodar, USSR was reported by Andreeva (1979)[71]. The extent of disease incidence was up to 80 per cent in Russia[108]. In India, it was recorded first time from Udaipur, Rajasthan by Nanda and Prasad (1974)[109] and later from Gujarat during 1980-81. The extent of disease incidence was up to 80 percent in Russia [108].

It appears at all crop growth stages but more conspicuous during flowering and spike formation stage [110]. It showed wilting of plants, root degeneration, collar rot, drooping of leaves, necrosis and finally leading to death of plants. Losses in yield were realized in all cultivated castor hybrids in Gujrat and as high as 85 percent wilt incidence has been reported under North Gujarat conditions [111,112].

Reniform nematode (*Rotylenchulus reniformis* Linford and Oliveira) were found to be involved in the wilt complex of castor. The plants attacked by reniform nematode are predisposed for the infection *Fusarium oxysporum* f. sp. *ricini*[113,114].

Wilt infected seeds carried out the inoculum at the micropylar end in 2-19 per cent seeds and seed infection was confined to testa, tegmen and endosperm in histology of seeds [115]. *F. oxysporum* f. sp. *ricini* was found seed-borne in 10.8 per cent seeds of castor variety Aruna collected from wilted plants [112,114]. The disease spread severely at the time of flowering and spike formation at 13-15^{0}C and but for symptom expression temperature is 22-25^{0}C[71]. Use of resistant verities, cultural practices, crop rotation and soil solarisation are common methods for controlling the disease. Treatment of seeds with thiram @ 2g/ kg or carbendiazim @ 2g/ kg seed or 4g of *Trichoderma viride* talc formulation, multiplication of 2kg of *T. viride* formulation by mixing in 50kg farm yard manure, sprinkling water and covering with polythene sheet for 15 days and then applying between rows of the crops are effective in reducing the incidence [93,110].

The bioefficacy of antagonist and botanical extract were tested *in vitro* against *Fusarium oxysporum* f. sp. *ricini*. *Trichoderma harzianum* (72.22%), *T. viride* (70.37%) and *Pseudomonas fluorescens* appeared potent antagonist against pathogen followed by *T. faciculatum*, *T. longibrachyatum* and *Bacillus subtilis*. Among the botanical, the extract of turmeric rhizome was effective in inhibiting mycelial growth 42.22 Per cent followed by 36.67% inhibition by leaves extract of marigold [23].

(i) MINOR DISEASES

Gray mold disease- It was first reported in the USA in 1918 by Stevens and Patterson and suggested that the causal organism of castor gray mold was an unknown *Botrytis* species [116,117]. In India, gray mold is found in few states but in Andhra Pradesh and Tamil Nadu regarded troublesome [118,119].

It is serious disease effected flowers and capsules directly and yield loss up to 100% during the continue rain at the time of capsule formation. The disease occurred in epidemic form in USA during 1958 and in Andhra Pradesh during 1987. Due to attack on plant the entire group of flowers converted to a prominent cottony mass of fungal growth. Initially small, blackish spots appeared from which drops of yellow may exude. Fungal hyphae from these spots spread the infection and produce cottony on inflorescence [93,119].

Rust disease- It is caused by fungi *Melampsora ricini* in castor symptomatically can be identified by minute, orange-yellow coloured, raised pustules with powdery masses on the lower surface of the leaves. These pustules are grouped in concentric rings and coalesce together finally drying of leaves. The disease can be control by removing the self-sown castor, weed hosts and plant debris. The spray of fungicide Mancozeb at 2kg/ha or Propioconazole 1l/ha is effective control of disease[93]. It is occur worldwide but in Maharashtra, Andhra Pradesh and Tamil Nadu it is a severe disease under moist conditions [80, 81].

Capsule Mold diseases- It is caused by species of *Alternaria*, *Penicillium* and *Fusarium* attack on capsules at an early stage of development and profusely bluish color in early stages and colour become darker or black in later stages [93].

Cotton root rot disease- It is caused by *Phymatotrichum omnivorum* is very susceptible and should not be planted in soils where the fungus is established. By using common cultural practices disease may be control effective[93].

Bacterial leaf Blight- It is prevalent in USA, Korea, Japan, Russia, Brazil, Sudan, South Africa and Uganda. In India, this disease was first reported from Gujarat (Patel et al., 1951). In India, it is reported from Bombay[120] and is similar to the one occurring in Japan, Korea and Uganda. Spots gradually turn black with dried sections of leaf tissue disintegrating and falling from leaves. Racemes are attacked under humid conditions[93]. The disease has also been observed in Tamil Nadu, Delhi, Andhra Pradesh and Rajasthan[121, 122].

Bacterial leaf spot- It is caused by *Xanthomonas campestris* pv. *ricinicola* syn: *Xanthomonas axonopodis* pv. *ricini* (Yoshii & Takimoto) Vauterin, Hoste, Kersters & Swings), *Xanthomonas campestris* pv. *ricini* (Yoshii & Takimoto) Dye, *Xanthomonas ricini* (Yoshii & Takimoto) Dowson in castor[81]. The pathogen attacks on cotyledonary leaves, lamina and veins raised numerous small rounds, water-soaked spots which later become angular and dark brown to black in colour. The diseased spots are generally aggregated towards the tip and in later stage the spots become irregular in shape, the areas around such spots turn pale-brown and brittle. Bacterial ooze is exudates on both the sides of the leaf which is in the form of small shining beads or fine scales [123]. In Texas and Oklahoma, an average 25% castor crop was lost due disease [124].

Bacterial leaf rust- It is caused by species of *Pseudomonas* in which the leaves and branches dry up, turn black and fall. The stems may be affected turn black and plants usually die[93].

FUTURE STRATEGIES

The diseases occur frequently in severe form and results in heavy losses because of lack of resistant varieties/hybrids for new emerging strains/races of pathogen. Effect of inter-cropping needs to be investigated and in this regard, genetic engineering

technology may play offers great potential role for the development of transgenic resistant plant. Use of chemicals may provide an effective control. The eco-friendly technology management is not costly and comparatively non-hazardous to the environment is better option to control the disease.

ACKNOWLEDGEMENT

Author is also grateful to Prof. Ashok Sharma, vice-chancellor, VMOU, Kota, Prof. Kailash Agrawal, Department of Botany, University of Rajasthan, Jaipur for Prof. R S Khangrot, Principal, Agrawal P.G. College, Jaipur, for their valuable guidance; faculty members of P.G. Department of Botany, Agrawal PG College, Jaipur for valuable support. The author is also thankful to all the scientists whom work is cited and could not acknowledge unknowingly and persons that directly or indirectly engaged in writing in this paper and during practical work.

REFERENCES

1. Phillips R and Rix M 1999, Annuals and Biennials, London: Macmillan. 106.
2. Anonymous 2014, Crop statistics in India www.indiastat.com
3. Mrutyunjay S 2013, Problems and prospects of oilseeds production in Rajasthan special reference to rapeseed & mustard (AERC report 147). Agro-Economic Research Centre For the states of Gujarat and Rajasthan (Sponsored by the Ministry of Agriculture, Govt. of India) Sardar Patel University, Vallabh Vidyanagar, Dist. Anand, Gujarat.
4. Adefris T and Nigussie A 1993, Castor in Ethiopia: Production, Utilization and research. Oil crops Newsletter 10. June 40–43.
5. Gobin AML, Uguru MI and Deckers J 2001, Crop Production in Tropical Africa. Castor: Goeklint graphics. p. 725-733.
6. Damodaran T and Hegde DM 2002, Oilseeds situation: A statistical compendium, D.O.R. Hyderabad, 210-229.
7. Pathak HC 2003, Emerging trends in castor seed development In: Proc. of Nat. seminar on castor seed, castor oil and its value added products 22nd May, 2003 Solvent Extract Association of India. Ahmedabad India. 54-62.
8. Ladda PL and Kamthane RB 2014, *Ricinus communis* (castor): an overview. Int. J. of Res. In Pharmacology and Pharmacotherapeutics, **3**(2) 136-144.
9. Ladda PL and Magdum CS 2012, Evaluation of anti tumor activity of *Ricinus communis* L. by proportion of nra. and bact. alert method. International journal of pharmacy and pharmaceutical sciences, **4**(3) 474-478.
10. Yusuf AK, Mamza PAP, Ahmed AS and Agunwa U 2015, Extraction and characterization of castor seed oil from wild *Ricinus communis* L. International Journal of Science, Environment and Technology, **4**(5) 1392- 1404.
11. Sharma PV 2006, Dravyagun vigyana vol-2 (vegetative drugs). *Chaukhambha Bharati Academy*, Varanasi, India, p.60.
12. Shokeen P, Anand P, Murali YK and Tandon V 2008, Anti diabetic activity of 50% ethanolic extract of *Ricinus cummunis* and its purified fractions. *Food and Chemical Toxicology*, **46** 3458-3466.
13. Pandey KN and Chaturvedi GN (Ed.) 2009, Charak samhita of agnivesh-

vidyotani hindi commentary (CS.Su.25.40). *Chaukhamba Bharati Academy*, Varanasi, India, pp.246.

14. Morya GCK, Kumari, G and Kumar G 2016, Indigenous knowledge on medicinal plants of siwan district of bihar, India, A paper presented in National Conference on Science for Rural India-2016 on 30-31 January 2016.
15. Agrios GN 2005, Plant pathology 5th edition. Elsevier, Academic press pp 952.
16. Neergaard P 1977, Seed Pathology. The MacMillan Press Ltd., London pp. 1187.
17. Bradbury JF 1986, Guide to Plant Pathogenic Bacteria. CAB International Mycological Institute (CMI), UK pp. 332.
18. Richardson MJ 1990, An annotated list of seed-borne diseases (4th edn). Proceedings International Seed Testing Association Zurich, Switzerland.
19. Anjani K, Raoof MA, Ashoka P, Reddy V, Hanumanta Rao C 2004, Sources of resistance to major castor (Ricinus communis) diseases. Plant Genetic Resources Newsletter, **137** 46–48.
20. Karaoglanidis GS, Karadimos DA, Ioannidis PM, Ioannidis PI 2003, Sensitivity of *Cercospora beticola* populations to Fentinacetate, Benomyl and Flutriatol in Greece. Crop Protection, **22** 735–740.
21. Marley PS and Gbenga O 2004, Fungicide control of *Stenocarpella maydis* in the Nigerian Savannah. *Archives of Phytopathology and Plant Protection*, **37** 19–28.
22. MamzaWS, Zarafi AB and Alabi, O 2012, Effect of six fungicides on sporulation of *Fusarium pallidoroseum* isolated from castor (*Ricinus communis*) in Samaru, Nigeria. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), **1**(5) 40-42.
23. Vahunia B, Singh P, Patel NY and Rathava A 2017, Management of fusarium wilt of castor (*Ricinus communis* L.) caused by *Fusarium oxysporum* f. sp. *ricini* with antagonist, botanical extract and pot experiment. *Int. J. Curr. Microbiol. App. Sci*, **6**(9) 390-395.
24. Singh RS 1955, Alternaria blight of caster plants. *Sci. & Culture*, **34** 130-39.
25. Jain AC, Nikam BG, Kulkarni SN and Sharma OP 1960, Fungi of Gwalior and Indore region. *The Vikram*, **4** 191-87.
26. Joshi NC and Vashist KPT 1959, Fungi of Ajmer (Rajasthan)-IV. Proc. Natl. Acad. Sci., India, **19** 147-50.
27. Pawar VH and Patel MK, 1957. Alternaria leaf spot of *Ricinus communis* L. India *Phytopath*, **10** 110-14.
28. Siddiqui MR 1963, Taxonomy and pathogenicity of the genus Alternaria with special reference to Indian species. *J. Indian Bot. Soc*, **42** 260-72.
29. Hasija SM 1964a, Additions to the fungi of Jabalpur (M.P.)-V. Mycopath. et *Mycol. Appl.*, **23** 33-41
30. Butler EJ and Hayman JM 1906, Indian wheat rusts. Mem. *Dept. Agric. India Bot*., Ser. **1** 1-53.
31. Prasad SS and Sinha BD 1962, Fungi causing diseases at Muzaffarpur-I. Proc. Natl. Acad. Sci., India, **32** 435-38.
32. Salam MA and Rao PN 1957, Fungi from Hyderbabd (Deccan)-I. *J. Indian Bot. Soc*, **36** 421-27.

33. Chowdhury S 1957, Notes on fungi from Assam. Lioydia, **20** 152-56
34. Karan D 1966, Some disease of Castor bean (*Ricinus communis* L.) from Hyderbad. Mycopath. Et. *Mycol. Appl*, **30** 187-189.
35. Karan D 1964, Some new hosts to *Leplosphaerulina* McAlp. from India-II. Mycopath. et *Mycol. Appl*, **30** 187-189.
36. Bose SK and Mathur SC 1939, A new leaf spot disease of castor bean (*Ricinus communis*). *Curr. Sci.,* **18** 210-11
37. Mundkur BB 1934, Oat Smut in India. *Indian J. Agric. Sci*, **4** 895-98.
38. Petrak F 1923, Mykologische Notizen. VI. *Ann. Mycol*, **21** 182-385.
39. Anonymous 1921, Proceedings of the Third Meeting of Mycological Workers in India held at Pusa on 7th February, 1921 and following days. supdt. Govt. Printing, Calcutta.
40. Kamal and Singh S 1975. Wet rot of castor plants. *Indian Phytopathology*, **28** 410-11
41. Aulakh KS 1970, Cladosporium rot of castor pods and its chemical control. *India phytopathology*, **23** 573-77
42. Marathe GV, Anahosur KH and Nalawadi VC 1973, A new twig blight of castor. *Indian Phytopath,* **26** 502-505.
43. Uppal BN, Patel MK and Kamat MN 1935, The fungi of Bombay. VIII. (Private Publication, pp. 1-56.
44. Butler EJ 1918, Fungi and Diseases in Plants. Thacker, Spink & Co., Calcutta.
45. Sydow H, Sydow P and Butler EJ 1906, Fungi indiae Orientails. Pars I. *Ann. Mycol,* **4** 424-45
46. Vember RN and MN 1964, Telia of rust of castor on castor. *Curr. Sci,* **33** 88.
47. Narayanaswamy P and Ramakrishnan K 1967-68, Powdery mildews of Coimbatore, Madras state. *The Madras Univ. J,* **37-38** (B) 84-99
48. Ramakrishnan, TS and Narsimhan IL 1941. Anew host-Ricinus communis for *Leveillula taurica* (Lev.) Arn. [*Oidiopsis taurica* (Lev.) Salm.]. *Curr. Sci*, **10** 211-12.
49. Patel MK, Kamat MN and Bhide VP 1949, Fungi of Bombay. Suppl. I. *Indian Phytopathology,* **2** 142-55.
50. Thomas KM and Ramakrishnan TS 1948, Studies in the genus Phytophthora, II. *Proc. Indian Acad. Sci.,* Sect. B, **27** 55-73.
51. Anonymous 1950, List of common names of India Plant Diseases. *Indian J. Agric. Sci,* **20** 107-142.
52. Butler EJ 1907, An account of the genus Pythium and some Chytridiaceae. Mem. Dept. *Agric. India Bot.* Ser, **1** 1-160.
53. Fitzpatrick HM 1930, The Lower Fungi-Phycomycetes. McGraw-Hill, New York.
54. Middleton JT 1943, The taxonomy, host range and georgraphic distribution of the genus Pythium. Mem. *Torrey Bot. Club*, *20* 1-171.
55. Butler EJ 1913, Pythium de Baryanum Hesse. Mem. Dept. Agric. India Bot. Ser., 5:262-67
56. Butler EJ (& Shaw FJF and McRae W) 1907-1930. Reports of the Imperial Mycologist. In Reports of the Agricultural Research Institute and College, Pusa Nos. 1-21.

57. Sydow H, Sydow P and Butler EJ 1907. Fungi indiae orientalis. Pars II. *Ann. Mycol,* **5** 485-515.
58. Wani DD and Thirumalachar MJ 1968, Studies on Elsinoe and Sphocelorna disease of plants in Maharashtra disease of some euphorbiaceous plants. *Indian Phytopathology*, **22** 404-05
59. Sastry KS 1980, Plant Virus and Mycoplasmal Diseases in India: A biboliography. Bharti Pub. Delhi, pp. 1-270.Shahnag D, Sumaira K, Marium T (2014) Seed borne mycoflora of castor bean (*Ricinus communis L.). Parkistan J. Bot*, **46**(4) 1485-1488.
60. Patel PN 1972, Bacterial Disease of Plants in ICAR, New Delhi.
61. Saharan GS 2005, Disease of oilseed crops Naresh Mehta and Sangwan, M.S.(Edt). Indus Publishing Company Delhi pp-631.
62. Sinha JN and Singh AP 1993, *Ricinus communis*: a new host for *Colletotrichum capsici*. *Indian Phytopath*, **46** 97.
63. Arsenuevic M, Masirevic S and Goto M 1992, First report of bacterial leaf spot of castor bean in Yugoslavia. *Plant dis*, **76** 1283.
64. Smith EF 1921, Bacterial wilt of castor bean (*Ricinus communis* L.). XXI (4):255-265.
65. Venkatesh R, Naik Ganesh and Vijayalakshman M 2003. Bacterial wilt of castor in Hassan district, Karnataka (Abstract). *Indian Phytopath*, **56** 334.
66. Siddaramaiah AL, Desai SA and Hegde RK 1980, Seed mycoflora of castor and its control. *Mysore J. agric. Sci*, **14** 500-502.
67. Vasudeva RS 1959, Diseases of castor In: Castor, Indian Central Oil Seeds Committee, Hyderabad, Chapter 12.
68. Alfieri SA Jr and Langdon KR, Welhburg C and Kimbrough JW 1984, Index of plant disease in Florida. Florida Dept. of Agric. & Consumer services, div. of Plant Industry, Bull. II (Revised) 38p.
69. Ikhatua MI and Dikoru MG 2011, Mycoflora of fruits and seeds of some *Jatropha* spp. and *Ricinus communis. Journal of Natural Sciences, Engineering and Technology*, **10**(2) 79-87.
70. Chukunda FA, Emri UN and Ukoima HN 2015, Studies of seed-borne mycoflora of castor bean (*Ricinus communis* L). *Academia Journal of Microbiology Research* **3**(1) 006-009.
71. Andreeva LT 1979, *Fusariums* wilt of *Ricinus communis*. *Zashchita Rastenil,* **7** 22.
72. Svirdvi AA 1989, Fusarium wilt of castor bean and its pathogenecity. *Fitopatologiya,* **23**(1) 91-94.
73. Raoof MA and Rao TGN 1999, Diseases of castor and their integrated management. D.O.R., Hyderabad. 33.
74. Rangaswamy G and Mahadevan 2005, Diseases of crop plants in India. 4th ed., *Prentice Hall of India Pvt. Ltd*., New Delhi-110001.
75. Nagaraja O, Krishnappa M and Sathisha AM. 2009. Seed mycoflora associated with castor, *Ricinus communis* L. and their effect on germination. *Journal of Oilseed Research,* **26**(2) 177-180.
76. Nagaraja O and Krishnappa M 2016, Location and Transmission of *Alternaria alternata*, *Botrytis ricini* in Castor (*Ricinus Communis* L.). SSRG *International Journal of Agriculture & Environmental Science*, **3**(4) 1-5.
77. Nagaraja, O and Krishnappa M 2016a, Wilt of Castor caused by *Fusarium*

oxysporum f.sp. *ricini*: Detection and Pathogenecity in Castor *(Ricinus communis* L.). *Seed International Journal of Scientific and Research Publications,* **6** (9) 214-217.

78. Dhrubash Karan. (1965), Some diseases of castor bean (*Ricinus communis* L.) from Hyderabad. *Mycology*, **6**(9) 37.
79. Weise EA 1971, Castor, Sesame and Safflower. Barnes and Noble New York.
80. Vaheeduddin S 1947, *Indian Council of Agricultural Research scheme* for research on disease of castor from 1943-1947.
81. Kulkarni LG and Ramanamurthy, GV 1977. Castor. Indian council of agricultural research, New Delhi. Pp-101.
82. Hickman C 1958, Presidential address: *Phytophthora*-plant destroyer. *Transactions of British Mycological Society,* **41**(1) 1-13.
83. Ko W 1981, Reversible change of mating type in *Phytophthora parasitica*. *Journal of General Microbiology,* **125**(2) 451-454.
84. Ashby SF 1927, *Macrophomina phaseolina* (Maubl.) Comb. Nov., the pycnidial stage of *Rhizoctonia bataticola* (Taub.) *Butl. Trans. br. Nycol. Soc*, **12** 141-147.
85. Maiti S and Raoof MA 1984, Aerial infection of *Macrophomina phaseolina* on castor. *J. Oilseeds. Res*, **1** 236-237.
86. Das ND and Prasad MN 1989, Assessment of yield losses due to root rot (*Macrophomina phaseolina* (Tassi) Goid) of castor in watershed areas. *Indian J. Plant Prot,* **17** 287-290.
87. Thompson A 1929, Phytophthora species in Malaya. *Malayan Agric. J,* **17** 53.
88. Liang PY 1964, Identification of Phytophthora species causing boll rot and castor bean blight in North China. *Acta Phytopath. Sinic,* **7** 11-20.
89. Kolte SJ 1995, Castor disease and crop improvement, Shipra Publications, Delhi. pp. 119.
90. Dastur JF 1913, On Phytophthora parasitica nov. species, a new disease of castor oil plant. mem. *Dep. Agric., India Bot,* ser. **5** 177-231.
91. Vasudeva, RS 1956, Overseas news: news from India, *Common Phytopathological News*, **2** 25-29.
92. Bhuvaneswari R, Velu Mani S, Prasad RD and Dinesh Kumar V 2015, Effect of Trichoderma mediated induced systemic resistance in castor bean against *Phytophthora parasitica* var *nicotianae*: National symposium on understanding host-pathogen interaction through science of omics March 16-17, 2015, Kozhikode, Kerala, India.
93. Anonymous 2018, https://plantdiseasehandbook.tamu.edu/industry-specialty/fiber-oil pecialty/castor/
94. Dastur J.F. 1913 *Phytophthora parasitica nicotianae* sp. A New disease of castor oil palnt. Mem. *Deparment of afgric. India, boranical survey*, **54**(4) 177-231.
95. Chibber MM 1914, A list of diseases of economic plants occurring in the Bombay Presidency. *Bull. Dept. Agric. Bombay,* **65** 17.
96. Stevenson EC 1945, *Alternaria ricini* (Yoshii) Hansfford, the causes of serious disease of the castor bean plant in the United States. *Phytopathology,* **35** 249.

97. Brigham RD 1961, Castor bean disease in Texas in 1960. *Plant Dis. Reptr*. **45** 124.
98. Chhata LK 2005, Evaluation of fungicides for the control of Alternaria blight of Castor. *Journal Mycology and Plant Pathology*, **35**(1) 88.
99. Stone WJ and Culp TW 1959, Effects of disease on castor beans in Missippi. *Plant Dis. Reptr*, **43** 827.
100. Masirevic S, Petrov M and Ceranic P 1993, *Alternaria ricini*, a new castor bean pathogen in Yugoslavia. *Zastita Bilja*, **44** 183-188.
101. McClellan Ki D 1944. A seedling blight of castor bean (*Ricinus communis*). *Phytopathology,* **34** 223-29.
102. Pandey BP 2001, Plant pathology. Schand publication, New Delhi pp 492.
103. Singh RS 2002, Plant diseases. Oxford and IBH Publishing Co., New Delhi, pp. 619.
104. Mehrotra RS and Arneja KR 1990, An Introductory Mycology. Wiley Eastern, New Delhi.
105. Mehrotra RS and Aggrawal Ashok 2003, Fundamentals of plant pathology. Tata McGraw hill education pvt ltd. New Delhi, India pp 420.
106. Claudino MR and Soares DJ 2014, Pathogenicity and aggressiveness of *Macrophomina phaseolina* isolates to castor (*Ricinus communis*). *Tropical Plant Pathology*, **39**(6) 453-456, 2014
107. Rieuf P 1953, A note on wilt of castor plant. rev. *Path. Veg*, **32** 120-129.
108. Moshkin VA 1986, Castor. Amerind Publishing Co. Pvt. Ltd., New Delhi.
109. Nanda S and Prasad N 1974, Wilt of castor, a new record. *J. Mycol. Pl. Pathol*, **24** 62-63.
110. Dange SRS, Desai AG and Patel SI 2006, Wilt of castor and its management - a review. *Agric. Rev,* **27** (2) 147 – 151.
111. Dange SRS, Desai AG and Patel DB 1997, Management of wilt of castor in Gujarat state of Indi. In: Proc. Int. Cpnfr. on Integrated Plant. Dis. Managt for sustainable Agriculture, 10-15 Nov., 1997, IARI, New Delhi, PP.107.
112. Dange SRS 2003, Wilt of castor-An overview. *J. Mycol. Pl. Pathol*, **33** 333-339.
113. Chattopadhyay C and Reddy MCM 1995, *J. Oilseed Res*, **12** 203-207.
114. Chattopadhyay C. et al. 1996, *J. Res*, - APAU, **24** 9-13.
115. Naik MK 1994. *J. Mycol. Pl. Pathol*, **24** 62-63.
116. Godfrey GH 1923, Gray mold of castor bean. *Journal* of *Agricultural Research*, **23** (9) 679-715.
117. Godfrey GH 1919, *Sclerotinia ricini* n. sp. on the castor bean (*Ricinus communis*). *Phytopathology,* **9** 565-567.
118. Moses GJ and Reddy RR 1989, Gray rot of castor in Andhra Pradesh. *J. Res*, APAU **17** 74-75.
119. Dange SRS, Desal AG and Patel SI 2005, Diseases of castor. In: G.S. Saharan; N. Mehta & M.S. Sangwan (Eds), 211-234, *Diseases of Oilseed Crops*, Indus Publishing Co, ISBN 81-7387-176-0, New Delhi, India.
120. Patel MK, Kulkarni YS and Dhande GW 1951, Bacterial leaf spot of castor. *Curr. Sci*, **20** 20.
121. Rangaswami G 1964, Occurrence of two bacterial plant diseases in South India. *Curr. Sci*, **33** 286.
122. Jindal JK and Patel PN 1972, New albino strain of *Xanthomonas*

ricinicola (Elliott) Dowson, an incitant of bacterial leaf spot disease in castor. *Indian Phytopath*, **25** 152-154.
123. Bonar SG and Rupert RA 2016, Bacterial diseases of crop plants. CRC Press Taylor and Francis group pp-594
124. Poole DD 1954, Disease observation on castor beans in 1953. *Plant Dis. Reptr*, **38** 218.
125. Singh RS 1973, Plant Disease. Oxford and IBH Publishing Co., New Delhi, pp. 103, 167.
126. Vazquez De Ramallo NE 1989, The leaf blight of castor bean (*Ricinus communis* L.) caused by *Phytophthora parasitica* Dastur. *Revista Industrial Y Agricola de Tucuma,* **66** 135-141.
127. Subramanian S and Sridhar TS 1966, Studies on the brown eye spot (*Cercospora coffeicola*) of coffee (*Coffee arabica*) I. Emanation of ethylene from infected leaves.
128. Tandon MP and Srivastava G 1977, Some new host records of phytopathogenic fungi. *Proc. Nat. Acad. Sci. India. B*, **47** 69-70.
129. Cook AA 1955, *Sclerotinia sclerotiorum* in castor bean in Florida. *Plant. Dis. Reptr,* **39** 585.
130. Chauhan LS, Swarup J and Saksena HK 1975, Studies on Myrothecium leaf spot of castor. *Indian J. Farm Sci,* **3** 111.
131. Sydow H and Butler EJ 1911, Fungi Indiae Orientalis Pars III. *Ann. Mycol,* **9** 372-421.
132. Rizwi MA 1978, Two Ascomycetous fungi new to India. *Geobios* **5** 172.
133. Muller KE and Houston BR 1960, Symptoms of Verticillium wilt of castor bean. *Phytopathology*, 50 85.
134. Hafiz A 1986, *Plant Diseases* Publ. by Pak. Agric. Res. Coun., Islamabad, p. 4-5.
135. Sandhu SS, Kumar S and Aharwal RA 2014, Isolation and identification of endophytic fungi from *Ricinus communis* L. and their antibacterial activity. *IJRPC,* **4**(3) 611-618.
136. Dawar S, Khalid S and Tariq M 2014, Seed borne mycoflora of castor bean (*Ricinus communis* L.) from Pakistan. *Pak. J. Bot*, **46**(4) 1485-1488.