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Diseases in berseem and its management: A review

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Abstract
Berseem (Egyptian clover) is popularly known as the king of annual leguminous fodder crop and cultivated as winter annuals in the tropical and subtropical regions on India. Berseem crop available for 6-7 month from November to May, give 4 to 6 cuts during winter, spring and early summer seasons and provides nutrition, succulent and palatable forage, milch animals yielding up to liters of milk can be maintained with a little supplement of concentrate mixture. Moreover, berseem has got a soil building characteristic and improves the physical, chemical and biological properties of the soil resulting in better growth and yield of crops in rotation. Thus, the crop is very important from the view point of conservation framing and important and imparts sustainability to soil productivity and crop production system as a whole. There are many biotic constraints of berseem production including fungi, viruses and nematodes. These causative agents hamper crop establishment, impair forage quality and reduce green fodder and seed yield. Besides this, they also cause indirect losses, like nodule formation in legumes ultimatelyresultingto reduction of nitrogen fixation capacity. Diseases are produced toxins, adversely affecting the animal health, which sometimes can be fatal.

Keywords: Berseem diseases, causative agents, management

Introduction
Berseem or Egyptian clover (*Trifolium alexandrinum* L. 2n=2x=16) is an important leguminous fodder crop for livestock feeding. It is quite nutritive, succulent, palatable and digestive fodder which is called king of the fodder, especially where irrigation water is available in plenty. Berseem forage contain 18-28 per cent crude protein which is equal to or better than crimson clover and alfalfa and it has 70 per cent dry matter digestibility (Karsli, *et al.*, 1999, Sharma *et al.*, 1974) [22, 37]. Iqbal and Iqbal (2014) [17] and Manjunath *et al.*, (2017) [28] also reported about nutritious quality of berseem (20% crude protein and 62% totaldigestible nutrient) and most potent milk multiplier. Berseem crops are being cultivated in Egypt, Israel, Syria, Pakistan, India and many other countries. In 1904, its seed were imported from Egypt to India and presently it is cultivated in Punjab, Haryana, Delhi, Uttar Pradesh, Gujarat, Bihar, Maharashtra, and Andhra Pradesh. Berseem clover is not seriously affected by the disease, but some disease has been identified caused by fungi, virus and nematodes which reduce the yield potential upto some extent (Mishra *et al.*, 1980; Windham and Pederson, 1988; Maghazy *et al.*, 2008) [31, 43, 27]. The important fungal, viral and nematodes causing severe diseases have been described in details.

Fungal Pathogen
Stem rot
This is caused by *Sclerotinia sclerotiorum* (Lib.) *de Bary* (Purdy, 1979) [35]. The sclerotia are distributed between fields on plant material by machinery, animals, flowing water and with seeds. Sclerotia that over season on the surface or in the soil or in crop debris or as admixture with the seeds. The crop is infected by the ascospores produced from germination of these sclerotia. Most suitable temperature for ascospore germination lies between 15-30^{0}C. Stem rot in clover crops infected by *Sclerotinia* spp. is also reported by Mattila *et al.*, (2010) [30], Ficker, (2019) [9] and Manjunath *et al.*, (2019) [29].

Symptoms
Fungus attacks the basal portion of the stem and causes it to rot. It produces white cottony mycelium which beings to grow on dead organic matter on the surface of the soil. The white mycelium can be very easily spotted in the field around the wilted patches of the berseem crop (Purdy, 1979, Faruqui, *et al.*, 2002 and Kumar and Singh, 2012, Bhatti and Kaur, 2019) [35, 8, 26, 5].

Disease management

The seed should be taken from the disease-free crop. Spray with 0.1 percent solution of bavistin twice during January and February at 15 days interval and avoid frequent irrigation. The field affected by the pathogen should be heavily flooded during the summer months for control of stem rot. After cutting, drenching of soil with 0.4% solution of brasicol is reported by Singh (2001). Cultural control of stem rot of berseem is reported by Singh and Singh (1995) [40]. Zaher, *et al.,* (2013) [40] reported stem rot management in Egyptian clover through biocontrol agent *Trichoderma harzianum* and *Bacillus thuringiensis. Sclerotinia sclerotiorum* can be manage by the use of the biological control agent *Coniothyrium minitans*, a mycoparasite that feeds on sclerotia of *S. sclerotiorum*, to reduce the sclerotia bank in the soil has yielded conflicting results between the regions where experiments have been conducted (Johnson and Atallah, 2014) [20]. Iqbal and Iqbal (2014) [17] reported economical control of rottening of berseem disease by using Thiophenate-M @ 500 g/ha (14.17%; 6.85% and 15.86%) followed by Propineb @ 1250 g/ha (12.91%; 6.10%; 13.86%); Fostyl-Al @ 500 g/ha (11.01%; 6.07%; 12.08%) and Carbendazim (12.33%; 5.60%; 11.29%).

Root rot

Causative agent and disease development

Berseem root rot is a complex disease incited by three most virulent pathogens, *viz*, *Rhizoctonia solani*, *Fusarium moniliforme* and *Sclerotinia bataticola* (Jobshy *et.al.,* 1981, Faruqui, *et al.,* 2002) [19, 8]. The occurrence of disease is common in the Gangetic and Central plains. Association of several fungi like *Rhizoctonia solani*, *Fusarium semitectum*, with nematode *Tylenchorhynchus vulgaris* have been reported with root rot complex (Kumar and Singh, 2012) [26]. The fungi only can incite the disease but the presence of nematode accelerates the infection rate causing serious damage to the crop (Hasan and Bhaskar, 2004) [13]. The fungus spores (Chlamydospores) and mycelium survive in the soil for longer period without host plant. When conditions are favorable, the fungus attacks on roots of berseem and cause rotting in root tissues. Initial symptom of spreading pathogen was wilting and affected tillers appeared under favorable environmental conditions in the form of patches (Rathi *et al.,* 2010) [36].

Symptoms

The first sign of the disease is evidenced by the dropping and morbidity of one or two tiller of the affected plants under favorableconditions, it appears in the form of definite patches (Faruqui, *et al.,* 2002, Iqbal and Iqbal, 2014) [8, 17]. The fungi only can incite the disease but the presence of nematode (*Tylenchorhynchus vulgaris*) accelerates the infection rate causing serious damage to the crop (Hasan and Bhaskar, 2004) [13]. Once the disease established in the field it becomes a permanent source of infection as the pathogen perpetuates in the soil through their resting structures. Heavy incidence of the disease reduces the plant density and the green fodder yield (Kumar and Singh, 2012) [26].

Disease Management

Follow 2-3-year crop rotation and deep summer ploughing. Seed treatment with carbendazim @2gm/kg seed. Barbetti, (1983) [4] reported fungicide drenches of benomyl, metalaxyl, iprodione, propamocarb, or thiram were applied to intact soil cores taken from known root rot affected fields in Western Australia, to control subterranean clover root rot. Metalaxyl was the most effective in reducing seedling damping-off. Chaudhry *et al.,* (1992) [7] reported cultural control of root rot disease of berseem. Control of root disease as seed treatment with thiram (0.25 per cent) and bavistin (0.1 per cent) followed by foliar spray of bavistin (0.1 per cent) can be practiced (Jain, 2001) [18]. Iqbal and Iqbal (2014) [17] find most effective fungicide thiophenate-M @ 500 g/ha against rottening of berseem/clover. Asghar *et al.,* (2019) [1] evaluated different fungicides against berseem root rot disease, he conveyed most effective and economical fungicide thiophenate-methyle followed by bromothalnil (@ 2.5 g/kg seed) for seed treatment to control root rot disease in berseem fodder crop.

Damping off

Causative agent and disease development

Damping off of berseemis caused by*Pythium spinosum* Sawada. It is soil-borne fungal disease that affects seeds and new seedlings, damping off usually refers to the rotting of stem and root tissues at and below the soil surface. In most cases, infected plants will germinate and come up fine, but within a few days they become water-soaked and mushy, fall over at the base and die.It appears more in wet soil and is further increased by poor soil drainage(Maghazy, *et al.,* 2008) [27].

Symptoms

Pre-emergence damping off, seed may decay or seedlings may become blighted and be killed before emergence. Post-emergence damping off, infection commonly occurs as the seedling emergences and it to wilt, collapse, dry up and die from a root at the soil line and below (Maghazy, *et al*., 2008) [27].

Management

Greenhalgh (1983) [12] showed that metalaxyl controlled root disease caused by *P. irregulare*. Greenhalgh and Clarke (1985) [10] used metalaxyl, benomyl, or metalaxyl + benomyl drenches to reduce both root rot severity and the incidence of *Pythium* spp. and *F. avenaceum* on subterranean clover roots. Smiley *et al.* (1986) [42] showed that root rots in subterranean clover could be reduced by treatment of seeds with fungicides, metalaxyl or benomyl or by drenching soils with these same fungicides. Subsequently, Hochman *et al.* (1990) [16] and Burnett *et al.* (1994) [6] confirmed that metalaxyl could provide useful control of root disease, especially that caused by *P. clandestina*, as did Greenhalgh *et al.* (1994) [11] for applications of potassium phosphonate, primarily against this same pathogen.Crop rotation,deep summer ploughing anduse of certified seed is effective to control the disease. Seed treatment with bio-agents i.e. *Paecilomyces lilacinus* (Maghazy, *et al*., 2008) [27], *Chaetomium globosum* or with fungicide Captan or Mancozeb combined with.

Viral Pathogen

Mosaic disease in berseem

Causative agent and disease development

Berseem Mosaic disease is caused by alfalfa mosaic virus (AMV). It is the type species of the genus Alfamovirus in the family Bromoviridae. Alfalfa mosaic virus has a genome causing of three, single stranded, positive-sense RNAs. RNAs1 and 2 encode proteins (P1 and P2) involved in virus replication (Nassuth and Bol, 1983; Herranz *et al.,* 2012) [32, 15]. A mosaic disease of Egyptian clover or berseem in India was sap-inoculable and transmitted by *Aphis gossypii* but not

by *A. rumicis* or *A. craccivora*. The virus, serologically related to alfalfa mosaic virus, and probably a new str. of that virus, was transmitted by 60-70% of *T. alexandrinum* seeds *(*Mishra *et al*., 1980, Pineyro *et al*., 2002) [31, 34].

Symptoms

Systemic light and dark green or yellow mottling is the most common symptoms. Vein yellowing leaf crinkling and distortionand some dwarfing (Mishra *et al*., 1980 and Norton and Johnstone, 1998) [31, 33].

Management

Use good quality genetically and physically pure seed. Use insecticide Dimethioate 20% EC @ 1-1.5 Lit/ha for aphid control or any other systemic insecticide for controlling aphids, help in reducing the disease (Singh, 2001) [39].

Nematode disease

Pathogen/causative agent

Root knot nematode is the important limiting factors to forge legume production and caused by *Meloidogyne incognita*; *Meloidogyne arenaria* (Baltensperger, *et al.*, 1985, Singh, *et al.*, 2010) [3, 41].

Symptoms

Root-knotnematodes do not produce any specificabove-ground symptoms. Affected plants shows stunting, wilting or chlorosis (yellowing), severe galling or knotted root system, excessive root branching in plants (Khan, 2015) [25].

Management

The nematode can be managed by introducing crop rotation with resistant varieties or non-hosts crop like sarson, toria, raya, taramira, gram, carrot, coriander, etc. is useful in bringing down soil nematode populations below the damage threshold level. Deep summer ploughing (2–3) at an interval of 10–15 days during hot summer months is helpful to reduce soil nematode populations.*Paecilomyces lilacinus*, *Pochonia chlamydosporia* etc. parasitize the eggs of *Meloidogyne* spp. (Khan, 2015) [25]. Integration of different tactics was found economical against root knot nematode (Khan *et al.*, 2009) [24]. Use nematicide Carbofuran 3G @ 25-30 Kg/ ha has been found effective (Kaushal *et al*. 2001; Kanwar and Bajaj, 2010) [23, 21]. Siddiqui (1997) [38] reported nematode management through organic amendments. Application of neem cake was found to be beneficial in suppressing nematodes associated with the fodder crop berseem (*Trifolium alexandrinum*) by Hasan and Jain (1984) [14].Azmi *et al.* (2000) [2] also observed that neem cake at 15q/ha suppressed the population of *Meloidogyne* spp., T*ylenchorhynchus* spp. And *Pratylenchus* spp. by 40, 40 and 10%, respectively on berseem.

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