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SOME OBSERVATIONS ON RHIZOPUS HEAD ROT OF SUNFLOWER IN FAJASTHAN, INDIA

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Summary

Head rot caused by Rhizopus nodosus Namyslov. was observed first of all in traces in 1972 and subsequently heavy outbreak was noted during March 1974 and April 1975 causing 40 and 12.5 percent rotting of heads in respective years. Attack of the pathogen was noted after initial damage to head either by head eating larvae Helinthia armioera Hb., birds or mechanical injury but major role is played by larvae as it bored the head and a close bearing was noted with the attack of larvae and percentage head rot. The disease has so far been reported as dry head rot but in present case wet rot symptoms were observed. Rotting heads turned soft and pulpy, many times detached from plants and fall down.

On breaking of stem at any point by wind or mechanical injury to the crop the pathogen caused stem rotting also which proceeded both upward and downward.

Just with the development of head rotting 4 to 8 leaves from top to downwards showed burning signs and later on turned black. Preliminary studies indicated the active role of cell wall degrading and macerating enzymes.

Subsequent to head rot several saprophytic fungi develop on heads. Seeds are much shrivelled and lose germinability. Removal of such heads before harvesting is essential as thrashing of these with general crop serves as a source to the flourishment of seed mycoflora, resulting in quick decline in viability during storage. One spray of Calixin 0.1% at seed setting appreciably checked head rot under artificial inoculations.

Ninety-one (91) sunflower cultivars were tested under artificial inoculations for resistance. Only four, namely Armavirec, Armavirskij 3497-K-1960, EC 50277 and L-Krasnodar K-2217 showed resistance.

Introduction

Rhizopus head rot of sunflower was first observed in traces during 1972 in Rajasthan (India) and since then it has been noted in serious proportion in some of the years in the state. Head rot has been reported from various sunflower growing countries as minor diseases only but recently Ivanchenka (1976) reported heavy damage due to this disease in central part of the northern foothills of the Caucasus (USSR) also during last several years and ranked it as second destructive disease after downy mildew of sunflower.

Usually the disease appears in Rajasthan near seed setting stage, characterized by small brown soft area on heads which quickly enlarges and whole of the head becomes soft, pulpy and rotten due to rapid growth of the fungus inside the receptacle. Seeds are also attacked by the fungus due to which shrivelled seeds with very poor germinability are produced. Severely infected heads many times get detached and fall on the ground, several saprophytic fungi, viz., Alternaria, Cladosporium, Trichothecium and Aspergillus spp. develop subsequently and the heads wither.

As per literature four species of Rhizopus have been reported on sunflower out of which, three species R. nioricans Chrenberg, R. nodosus Namyslov and R. arrhizus Fischer have been reported to cause head rot and rot of seeds of maturing inflorescence (Prissyajnyuk, 1931; Zella, 1932 and Arnan et al, 1970), while R. stolonifer has been reported to cause decay of stem immediately below inflorescence (Gradinaroff, 1943). The pathogen causing head rot in Rajasthan was identified as Rhizopus nodosus Namyslov (Agrawat et al, 1976 unpublished and Jain et al, 1976).

While studying the symptoms some interesting observations not described earlier were observed. In the present paper such symptoms have been described along with preliminary studies on the mechanism of rotting, loss estimation, factors involved in head rot development and methods to reduce its damage by Sanitation, chemical control and resistant cultivars.

Materials and Methods

Inoculation tests were normally carried out by incision method, i.e., by cutting open a slit in the head and inserting mycelial bit in it. Heads in which pollination just completed were selected for inoculations and studies. After 15 days of inoculation rotting of complete head was observed. Therefore, observations in the trials of chemical control and varietal screening were recorded after 15 days of inoculation. Head rot percentage was calculated from the infected number of heads while percentage disease intensity for chemical control trial was calculated from percentage head area rotted in each inoculated plant of a treatment.

To assess losses, per plant yield of 50 heads each healthy and rotted of uniform size was recorded and average calculated. Germination percentage of seeds from healthy and diseased plant was calculated on the basis of germination of 300 seeds.

For studying mechanism of rotting, pathogen was grown on Czapeks liquid medium for 10 days. The cultural filtrate was filtered through Whatman filter paper No. 42, centrifuged at 3000 r.p.m. for 15 minutes and was used for testing enzymic activity on potato discs by Brown's method (1915), as well as for inoculation of heads.

Since the growth of pathogen is inside receptacle and its damage is noticed only after appearance of rotting spots, appropriate time to start with chemical control measure is not easily assessable. However, looking to the damage near seed setting and internal growth of fungus, search for a systemic fungicide which on one spray at this stage may check the growth of pathogen is appealing. With this view, six systemic fungicides viz. Benlate (Methyl 1-(Butyl carbamoyl) -2-benzimidazola-carbamoyl), Tecto - 90 (90% Thiabendazole), Vitavax (2-3 dihydro-5-carboximide-6-methyl-1,4-oxathin), Bavistin (2-(Methyl carbamoyl)-2-benzimidazol carbamoyl), Calixin (2-6-dimethyl 4-tridecyl morpholine) and Plantvax (5,6, dihydra-2-mathyl-1,4-oxathin-3-carboxinilide-4,4-dioxide) were tested in micro plots in field under artificial inoculation with 10 replications. The concentrations used for spray were 0.05, 0.1 and 0.2 percent solution of each in water. Just after inoculation one spray of respective fungicide was given. Inoculated heads with no treatment were kept as check.

In order to screen the cultivars for resistance against the head rot pathogen, cultivars were raised in field and preliminary screening was done by usual incision method described above. Cultivars showing resistance were finally tested to confirm resistance by injecting 2 ml heavy spore suspension through the incision. Cultivars were grouped in different categories as follows:

1. Resistant - Free of infection.
2. Moderately resistant - Up to 10 percent area of heads rotted.
3. Moderately susceptible - 11 to 40 percent area of heads rotted.
4. Susceptible - Well spread infection on all the heads with complete rotting.

Results and Discussion

Symptoms

Rotting of sunflower heads due to different *Rhizopus* species have so far been described as dry rot (Prissyajnyuk, 1931; Zelle, 1932 and Ivanchanko, 1976) but during present observations soft rot symptoms were observed due to *R. rodosus*. Undetached rotted heads at later stage of course dried up prematurely but it would not be justified to call it as dry rot.

Just with the development of head rotting, 4 to 8 leaves from top to downwards showed burning signs which soon turned black and dried while remaining lower leaves were still green and healthy. This can be attributed to the probable translocation of certain toxic chemicals from rotting heads to leaves, which is being studied at this station.

It was further interesting to note that occasionally the pathogen caused only stem rotting at the point of its breaking. Stem breaking was usually noted in field either due to mechanical injury, wind or overweight of growing heads. Rotting of stem proceeded both upwards and downwards causing dysfunction of vascular supply. Heads of such plants hanged down, dried prematurely and yielded shrivelled or no seed depending on the time of such attack.

Mechanism of Head Rot

Cultural filtrate caused similar rotting of heads as is caused by the pathogen and potato discs when placed in it also lost coherence within 9 hours. This preliminary observation indicates the role of macerating enzymes in inducing soft rot symptoms. Boiled cultural filtrate could neither induce head rotting nor mascerate potato discs. Further studies are in progress.

Factors Involved in Head Rot Development

As a result of inoculation tests it was established that the pathogen is a weak parasite and attacks heads and stem only after injury. Observations recorded so far revealed that head is damaged either by Lepidopterous larvae Heliothia armioera Hb., birds (especially parrots) or sometimes due to mechanical injury, and that serves as avenue for the pathogen. Out of these Heliothis played major role. It is one of the major pests of the crop grown during winters (Rabi). Its adult moths usually lay eggs on opening flowers during November to March. On hatching, the larvae penetrate the receptacle and start eating heads from inside. Soon after this Rhizopus developed into it causing soft rot. The percentage attack of sunflower heads by the Heliothis larvae had a close bearing with head rot incidence (Table 1). Maximum rotting to an extent of 40.0 and 12.5 percent was noted during March-April in both the years 1974-75 and 1975-76 during Rabi crop when attack of Heliothis was also appreciably more. Head rot incidence in other seasons was quite less, i.e., ranging from 1.4 to 2.5 percent when Heliothis did not occur. This indicates the role of other agencies too in head rot incidence throughout the year, as has been indicated earlier. Arnan et al (1970) noted that infection of sunflower head rot pathogen R. arrhizus occurred in larael only following injury to the heads after flowering, possibly from birds. Mishra et al (1972) indicated the presence of a some unidentified larvae in Rhizopus rotting heads in India and attributed that injury by the larvae serve as the avenue for entry of pathogen, while other reports (Prissyajnyuk, 1931; Zelle, 1932; Gradinaroff, 1943 and Ivanchenko, 1976) do not speak of the role of any of these agencies.

TABLE 1. Incidence of head rot and Heliothis in different seasons.

Year	Season*	% Head Rot Incidence	% Heads Attacked by Heliothis larvae
1974	Kharif	2.5	0
1974-75	Rabi	40.0	29.4
1975	Zaid	1.9	0
1975	Kharif	2.0	0
1975-76	Rabi	12.5	10.2
1976	Zaid	1.4	0

* Kharif - Crop sown during rains, i.e., July-August
Rabi - Winter crop sown during November-December
Zaid - Summer crop sown during March.

Loss Estimation

Observations revealed that the head rot disease caused losses to the sunflower crop directly as well as indirectly. Direct losses are due to reduced yields, shrivelled seeds with poor test weight and germinability (Table 2). Indirect losses are due to harvesting and thrashing of rotted heads mixed with general healthy crop. Under such situations seed mycoflora flared up during storage resulting in quick deterioration of germinability of complete seed lot. Just after six months of storage, germination percentage of such samples from

1974-75 rabi produce declined to 46.0% from 81.5% and lost complete viability after a year of storage, which is quite unusual and badly affects quality and commercial value of seed.

TABLE 2. Effect of Rhizopus head rot on sunflower.

Plants	Per plant yield in g.	1000 seed wt. in g.	Percentage germination of seed
Healthy	52.84	47.30	98.0
Diseased	11.05	15.85	16.0

Methods to Reduce the Damage

(a) Sanitation - Removing of affected heads before harvesting is essential for maintaining quality of seed. Ivanchenko (1976) also suggested sorting off of affected heads and subsequent burning, which undoubtedly appears to be an effective measure under present situations.

(b) Chemical Control - Practically little work has been done to control the disease because of the fact that it has so far been known as a minor disease. Arnan et al (1970) noted good control of head rot by a single application of Cu-8-Quinolate. Significant control of the head rot has also been reported by fungicides Bavistin as well as Dithane M-45 M-45 (Anonymous, 1978) but none of these chemicals were effective under artificial inoculation studies. The only effective chemical observed was Calixin at 0.1%. Mean percentage diseases intensity in this treatment was 25.1% as against cent percent rotting in other treatments including check which indicated that the pathogen cannot be checked completely. However, its damage can be reduced up to an extent by a single spray of Calixin just after pollination is complete. Ivanchenko (1976) observed that utilization of common fungicides though not eliminates the disease fully, hampers its development and increase the absolute seed weight and their planting properties.

Looking to the major role of Heliothis larvae, a two pronged attempt to check the larvae by one spray of insecticide like Endosulfan at 0.05% along with Calixin at flowering can be more effective for rabi crop, when Heliothis adults lay eggs normally. Endosulfan has been found significantly effective in killing Heliothis larvae (Anonymous, 1977). After penetration of larvae in heads, insecticidal application is however little helpful in causing effective mortality and thus development of Rhizopus head rot is inevitable if fungicidal application is not followed. With this view, experiments on proper stage and time of insecticidal application are in progress at this station.

(c) Use of Resistant Cultivars - Out of 91 cultivars tested only four viz. Armavirec, Armavirskij 3497-K-1960, EC 50277 and L. Krasnodar-K-2217 were found resistant to the head rot pathogen. No rotting could be induced in these cultivars by present isolate. The first cultivar is from Canada while other three are from USSR. Five each were found moderately resistant and moderately susceptible while rest all were found as susceptible cultivars (Table 3). Resistant cultivars can be used for breeding purpose or direct cultivation.

TABLE 3. Reaction of sunflower varieties against R. nodosus.

Resistant:	Armavirec, Armavirskij 3497-K-1960, EC 50277*, L-Krasnodar K-2217.
Moderately resistant:	B.A. 034-A, CPI 25922, EC 28638, HT 50 CRM, Saratovskyz rannij K 989 (Str.).
Moderately susceptible:	Advance hybrid, EC 93982, HT 60 CRM, Latur selection, P 21 MS-VRZ (Lot 9915 Str.).
Susceptible:	A 49408-HS61, Advance, Armaviretz, Armavirskij 3497, Borowski Ulkepszony, BA 007, BA 019, BA 019-A, BA 024, BA 036, BA 079, Cernianka-66, Commander, Corodobes, Csakinszki, EC 16400 (Str.), EC 26993, EC 27269 (Str.), EC 27638, EC 27668, 75210-1, 75268M-1, 75268M-2, EC 75269, EC 75793, EC 83096, EC 85815, EC 85815-1, EC 85816, EC 98901, EC 101499, Eraso No.1 MMM, Giant 549 K-549, Girason Tecnoni, Guayacan, Guayacan (Str.), Guayacan Inta, HA61, HS 52, HS 53, HS 301, Hybrid HS 52, Hybrid HS 53, Hybrid HS 64, Hybrid hysan 10, Hybrid hysan 20, Hybrid hysan 30, Hybrid hysan 391, Impira, Impira (Str.), Impira Inta, K 187, K-1965, Klein (Str.), Kriswardi, Luc 2181, (Krasnodar territory-2), Luch, Malwi, No. 75, No. 75 (Str.), Peredovik, Peredovik-K 2051, P21-MS-Vr, Smena, Stella, Sungold yellow, Szalzut, VI-2-3-Lovarzaptonai, VNIIMK 1646, VNIIMK 1646-K-1650, VNIIMK 6540 K-1872, VNIIMK 6540, VNIIMK 8931, VNIIMK 8937, Wielkopolski (Str.), 2-19, 1585/4, 1785/19.

* EC - Exotic collection number of the cultivar sent by Director Plant Production, India, name of which not known.

Searching of cultivars resistant to Heliothis armigera can also be much useful in minimizing the damage to heads by larvae. This seems to be another approach for head rot control. Preliminary observation in India (Anonymous, 1976) indicated twenty-two cultivars resistant to H. armigera. However, further studies to confirm it are needed.

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References

ANONYMOUS. Report of the All India Coordinated Research Projects on Oilseeds for the year 1974-75. P. 307 (1976).

ANONYMOUS. Annual Progress Report 1976 of All India Coordinated Research Project on Oilseeds. P. 208 (1977).

ANONYMOUS. Annual Progress Report 1977-78 of All India Coordinated Research Projects on Oilseeds 2:384 (1978).

*ARNAN, M., M.J. PINTHUS and R.G. KENNETH, 1970. Epidemiology and control of a sunflower head rot in Israel caused by Rhizopus arrhizus. Can. J. Pl. Sa. 50(3):283-288.

BROWN, W., 1915. Studies in the physiology of parasitism. The action of Botrytis cineria. Ann. Bot. 20:313-348.

*GRADINAROFF, L., 1943. On the etiology of potato tuber rots of complex genesis. Arab. biol. Aust. (Reichsanst). Berl. 23(4):405-426.

IVANCHENKO, M.Y., 1976. Sunflower dry rot and methods to reduce its damage. VIII International Sunflower Conference, Krasnodar. Abstr. of papers. p. 137-138.

JAIN, K.K., H.K. GUPTA, O.P. VAISH, and J.M. AGRAWAT, 1976. Reprot of Research work donw at Sunflower Research Station, Kota, India. VIII International Conference, Krasnodar. Abstr. of papers. p. 12-14.

MISHRA, R.P., U.S. KUSHWAHA, M.N. KHARE, and J.N. CHANO, 1972. Rhizopus rot of sunflower (Helianthus annuus) in India. Indian Phytopath. 25(2):236-239.

*PRISSYAJNYUK, A.A., 1931. Contribution to the study of fungus diseases of field crops in the lower Volga region. Plant Protection, Leningrad. VII, 4-6:323-337.

*ELLE, M.A., 1932. Sunflower diseases. Pan-Soviet State Assoc. Control of pests and diseases in Ag. and Sylvic.

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* Original not seen.