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EFFECT OF FOLIAR APPLICATION OF MONOCROTOPHOS ON THE EAR-COCKLE DISEASE ON WHEAT

by

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Summary. Wheat cvs viz. RR-21, HD-2285, HUW-234, UP-262, WH-283 and Lokone, inoculated with 20,000 juveniles of *Anguina tritici*/kg soil, developed crinkling and rolling of leaves and exhibited significant suppression of dry weight of plants and number and weight of grains/plant in a field trial. Two cvs (WH-283 and HUW-234) produced greater number of ears in the presence of the nematode but their yields were significantly decreased. All the cvs produced cockles which ranged from 17 (HUW-234) to 26 (RR-21)/plant. Foliar application of monocrotophos at 1 kg/ha on one month old plants led to recovery from nematode attack, and subsequently yield of all the cvs was improved satisfactorily. Cockle formation was greatly suppressed and in cvs RR-21 and HUW-234, no cockles were recorded.

Ear cockle of wheat caused by the seed-gall nematode, *Anguina tritici* (Steinbuch) Chitw., is an important disease in the Indian subcontinent, West Asia and to some extent in China (Swarup and Sosa-Moss, 1990). In India, the disease is quite common and frequently appears in northern states such as Madhya Pradesh, Rajasthan, Punjab, Haryana, Bihar and Uttar Pradesh (Paruthi and Bhatti, 1990). The wheat cvs sown in December are very susceptible to nematode infection due to the prevailing humid climate that favours nematode migration on plant and leaf surface (Southey, 1978). Second stage juveniles that emerge from seed-galls (cockles) feed ectoparasitically on the tips and margins of growing leaves and shoot meristem, and endoparasitically on embryonic ears (floral parts) as the stem elongates (Gokte and Swarup, 1987). Endoparasitic feeding by the juveniles transmutes the ovule and other floral parts into galls, which eventually turn brown or

black (cockles). Symptoms of nematode attack such as crinkling and rolling of the leaves can be discerned at the seedling stage, but farmers generally fail to recognize the disease before harvesting and threshing the plants. Yield losses may be as high as 69-93% (Anwar and Haq, 1992). Recently Khan and Athar (1996) reported 6-18, 12-28 and 24-43% decrease in weight of grains/plant at 15,000, 20,000 and 30,000 J2/plant, respectively.

The seed-gall nematode has been virtually eliminated where seed cleaning of commercial stocks is undertaken. In Asian developing countries neither this technique nor flotation in brine water is practised. Farmers, however, usually spray wheat crops with a single application of a broadspectrum pesticide such as monocrotophos to protect from insect pests like army worms, termites, aphids etc. In the present study, monocrotophos was tested against *A. tritici* on wheat under field conditions.

Materials and methods

Six cultivars of wheat (*Triticum aestivum* L.) viz. RR-21, HD-2285, HUW-234, UP-262, WH-283 and Lokone, obtained from Quarci Agricultural Farm, Aligarh, were sown in four field plots, identical in all respects, in the second week of December, 1994. Three rows were maintained for each cultivar in every plot, which were randomly distributed. Two days after sowing, two plots were inoculated with 20,000 J2 of *A. tritici* /kg 10 cm top soil of each row. Nematode suspensions were prepared by gently crushing water soaked seed-galls and collecting the juveniles on a 500 mesh sieve. Non-inoculated plots served as control. One month old plants of two plots viz. one inoculated with the nematode and the other uninoculated were sprayed with monocrotophos at 1 kg/ha.

A plot was left inoculated with nematodes and unsprayed with the pesticide to serve as a control. Plants were regularly observed for the appearance of symptoms of nematode infection. Plants were harvested three and a half month after sowing and weight of dry plant (excluding ears and roots), number of ears/plant, length of ear, number of grains and cockles/plant and

weight of grains/plant and seed galls were recorded. The data were processed by a two factor analysis of variance (ANOVA) and least significance difference was calculated at $P=0.05$ (Dospikhov, 1984).

Results and discussion

Inoculation with *A. tritici* caused crinkling and rolling of the leaves of all six cultivars. Symptoms were more discernable on young plants (about 30-45 days old) and there were no apparent differences in the disease severity among cultivars. The application of monocrotophos checked the development of foliar symptoms and leaves regained their normal appearance within two weeks after application of the spray, whereas on unsprayed plants the symptoms lasted for a further 3-4 weeks. Monocrotophos spray reduced the intensity of leaf symptoms, especially on cvs HD-2285, RR-21 and UP-262.

Nematode infection adversely influenced dry matter production and yield of all the six cultivars (Table I-V). Weight of dry plants (excluding ears and roots) was significantly decreased (ex-

TABLE I - Effect of monocrotophos sprays on the weight of dry plants (excluding roots and ears) of wheat cultivars inoculated with *Anguina tritici* or uninoculated.

Treatment	Cultivar					
	RR-21	HD-2285	HUW-234	UP-262	WH-283	Lokone
0 J2	5.5	5.3	4.5	4.3	6.2	4.8
20000 J2	4.2*	4.4*	4.3	4.1*	4.5*	4.0*
0 J2 + Spray	5.7	5.3	4.5	4.4	6.3	4.7
20000 J2 + Spray	5.2*	4.9*	4.4	4.3*	5.7	4.4*
L.S.D. (P=0.05)	0.29	0.32	0.25	0.18	0.35	0.26
F-value (P=0.05)						
Nematode (df=1)	70.2**	55.0**	NS	8.3**	79.4**	40.7**
Pesticide (df=1)	NS	NS	NS	NS	NS	NS
Interaction (df=1)	25.1**	19.6**	NS	8.1**	33.8**	11.5**

Each value is mean of 10 replicates; * significantly different from the respective controls; ** significant; NS Not significant.

TABLE II - *Effect of monocrotophos sprays on the ear formation (no. of ears/plant) of wheat cultivars infected with A. tritici or uninoculated.*

Treatment	Cultivar					
	RR-21	HD-2285	HUW-234	UP-262	WH-283	Lokone
0 J2	2.85	3.20	2.57	2.40	3.08	2.60
20000 J2	2.61	2.95	2.78*	2.31	3.41*	2.35*
0 J2 + spray	2.89	2.12	2.59	2.42	3.12	2.58
20000 J2 + spray	2.73	3.06	2.66	2.30	3.29	2.48
L.S.D. (P=0.05)	0.27	0.32	0.18	0.35	0.29	0.21
F-value (P=0.05)						
Nematode (df=1)	NS	NS	4.9**	NS	7.2**	7.5**
Pesticide (df=1)	NS	NS	NS	NS	NS	NS
Interaction (df=1)	NS	NS	NS	NS	NS	NS

Each value is mean of 10 replicates; * significantly different from the respective controls; ** significant; NS Not significant.

TABLE III - *Effect of monocrotophos sprays on the ear length (cm) of wheat cultivars infected with A. tritici or uninoculated.*

Treatment	Cultivar					
	RR-21	HD-2285	HUW-234	UP-262	WH-283	Lokone
0 J2	8.7	8.8	9.2	8.9	8.6	9.4
20000 J2	7.9*	7.9*	7.5*	7.8*	7.9*	7.8*
0 J2 + spray	8.8	8.9	9.5	8.9	8.6	9.7
20000 J2 + spray	8.5*	8.7*	8.5*	8.3*	8.5	8.9*
L.S.D. (P = 0.05)	0.52	0.69	0.48	0.65	0.57	0.61
F-value (P=0.05)						
Nematode (df=1)	34.0**	29.5**	41.2**	25.5**	21.9**	38.5**
Pesticide (df=1)	NS	NS	NS	NS	NS	NS
Interaction (df=1)	5.6**	10.7**	8.3**	NS	12.4**	17.3**

Each value is mean of 10 replicates; * significantly different from the respective controls; ** significant; NS Not significant.

cept cvs HUW-234), being greater in WH-283 (27.4%) followed by RR-21 (23.6%) compared to uninoculated plants (Table I). Application of monocrotophos, however, led to a significant increase in the dry matter production of the wheat cultivars (except HUW-234 and WH-283) inoculated with the nematode, in comparison with inoculated untreated plants.

Nematode infection caused both inhibitory as well as stimulatory effects on ear formation (Table II). Cultivars WH-283 and HUW-234 produced greater numbers of ears (10.7 and 8.2%, respectively) in the presence of *A. tritici* compared with uninoculated plants. In the remaining cultivars, however, ear formation was suppressed, being significant in cv. Lokone. Aver-

age length of ear was decreased significantly in all the cvs infected with the nematode. Monocrotophos treatment also checked this negative effect of the nematode with the result that ear length increased significantly, except cv UP-262, compared to plants in control plots (Table III).

The number of grains/plant was adversely affected by nematode inoculation (Table IV). *A. tritici* caused a significant decline in the number of grains/plant in all the cvs being greatest in cvs RR-21 (67.4% decrease) and HD-2285 (37.7%). Sprayed plants recovered from the nematode attack and produced greater number of grains, especially the cvs HD-2285 (46% increase) and RR-21 (42.3%) compared with the control. In other cultivars the increase was not significant, but it was also not significantly less than the uninoculated-treated or untreated plants (Table IV). Yield, in terms of weight of grains/plant, declined significantly in all the cultivars in the presence of the nematode, being greater for cvs HD-2285 (40.4% decrease) and RR-21 (36.7%). In the remaining cvs, yield decline varied from 10 to 14% (Table V). Significant enhancement in yield as a result of spraying with monocrotophos occurred in all the cvs

except UP-262. In none of the cvs was there a significant yield difference between inoculated-treated plants and control plants.

All the cvs inoculated with *A. tritici* produced seed-galls (cockles) to a varying extent (Table IV). Maximum cockles were recovered from the RR-21 (26) followed by UP-262, WH-283, HD-2285, Lokone and HUW-234. Application of monocrotophos effectively checked the conversion of healthy grains into cockles and no cockled seed was recovered from HUW-234 and WH-283, whereas in other cultivars only a few cockles were formed (Table IV).

The present study revealed that seed-gall formation alone does not seem to be an efficient variable to assess reaction of wheat cultivars against *A. tritici*. Because order of relative susceptibility among the cultivars used varied with the variables. For example, seed-gall formation was in the order of RR-21 > UP-262 > WH-283 > HD-2285 > Lokone > HUW-234, whereas yield decline was HD-2285 > RR-21 > WH-283 > HUW-234 > Lokone > UP-262. This indicates that yield reduction was not only due to conversion of healthy grains into cockles but also due to suppression of seed formation and their

TABLE IV - Effect of monocrotophos sprays on normal grain and cockle formation (no. of grains/cockles/plant) of wheat cultivars inoculated with *A. tritici* or uninoculated.

Treatment	Cultivar					
	RR-21	HD-2285	HUW-234	UP-262	WH-283	Lokone
0 J2	221	199	215	226	219	184
20000 J2	137*/26	124*/20	191*/17	198*/24	193*/21	163*/18
0 J2 + spray	218	206	219	220	228	189
20000 J2 + spray	195*/2	181*/2	202/0	205/3	205/9	175/0
L.S.D. (P=0.05)	26.9	17.5	24.9	18.3	18.1	17.2
F-value (P=0.05)						
Nematode (df=1)	80.3**	85.3**	12.1**	17.5**	23.7*	26.8**
Pesticide (df=1)	NS	NS	NS	NS	NS	NS
Interaction (df=1)	39.6**	33.7**	NS	NS	NS	NS

Each value is mean of 10 replicates; * significantly different from the respective controls; ** significant; NS Not significant.

TABLE V - Effect of monocrotophos spray on weight of normal grains/plant (g) of wheat cultivars inoculated with *A. tritici* or uninoculated.

Treatment	Cultivar					
	RR-21	HD-2285	HUW-234	UP-262	WH-283	Lokone
0 J2	9.8	8.9	7.3	8.8	9.2	6.6
20000 J2	6.2*	5.3*	6.3*	7.9*	7.9*	5.8*
0 J2 + spray	9.7	8.8	7.2	8.9	9.0	6.7
20000 J2 + spray	9.6*	7.9*	7.0*	8.1	8.7*	6.4*
L.S.D. (P=0.05)	0.71	0.59	0.42	0.48	0.52	0.40
F-value (P=0.05)						
Nematode (df=1)	40.5**	43.8**	10.5**	7.3**	18.3**	14.9**
Spray (df=1)	NS	NS	NS	NS	NS	NS
Interaction (df=1)	32.6**	25.1**	6.2**	NS	9.4**	7.3**

Each value is mean of 10 replicates; * significantly different from the respective controls; ** significant; NS Not significant.

subsequent development (Khan and Athar, 1996). The cvs WH-283 and HUW-234 produced greater number of ears in the presence of *A. tritici* but yields were significantly reduced. Ectoparasitic feeding by *A. tritici* sometimes stimulates tiller formation and subsequently ears, but yield decreases due to endoparasitic feeding on developing grains (Swarup and Sosa-Moss, 1990). Treatment of plants with monocrotophos may have killed the juveniles of *A. tritici* primarily through its contact action. At the time of spraying (before the initiation of embryonic ears) the nematodes may have been feeding ectoparasitically on leaf margins, bud axils etc. (Southey, 1978). Partial systemic action of the pesticide also may have contributed to suppression of seed-gall formation (Matsumura, 1975). Our results, however, demonstrated that monocrotophos can satisfactorily control ear-cockle disease, if applied at seedling stage before the initiation of inflorescence. But the most effective and economic control is the use of "clean" seed, which is usually achieved by simple seed-cleaning procedures.

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