

Eco-friendly pest management in berseem (*Trifolium alexandrinum*) and mustard (*Brassica comprastis*) mixed forage crop

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ABSTRACT

Various combinations of botanicals were evaluated for the management of pests/diseases in berseem (*Trifolium alexandrinum* L.) mixed with mustard (*Brassica comprastis*(Linn.)Watt.) fodder production. The treatments were factorial combinations of seed/soil treatments and foliar spray treatments. Although maximum biotic stress management was achieved in synthetic pesticidal combinations in which a reduction of 68.76% in the root rot (*Rhizoctonia solani* and *Fusarium semitectum*) intensity in berseem and a reduction of 68.22% aphid (*Lipaphis erysimi* Kalt) population in mustard was recorded, however, among various combinations of botanicals seed coating with neem seed kernel powder (50 g/kg seed) + sprays of 3% neem seed kernel extract provided maximum protection (a reduction of 68.22% in the root rot intensity in berseem and a reduction of 70.28% aphid population in mustard) consequently an increase of 33.61% in green forage yield over the control. This combination of botanical provided maximum protection to the crop against plant parasitic nematode, *Tylenchorhynchus vulgaris* (a reduction of 42%). This combination of botanical treatment also harboured maximum number of beneficial soil micro-arthropods, viz *Folsomia* sp., *Brachystomella* sp. (Collembolans) and *Prostigmata*, *Mesostigmata* and *Cryptostigmata* (Mites) (approximately triple population of beneficial Collembolans and mites in comparison with untreated check). The economics of various botanicals experimented revealed maximum net returns in pre-sowing treatment with Trineem and post sowing treatment with 3% neem seed kernel extract, followed by pre-sowing treatment with Trineem and post-sowing treatment with 0.07% endosulfan + 0.09% mancozeb where a cost : benefit ratio of 2.03 and 2.01 was worked out. Seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract gave cost : benefit ratio of 1.94.

Key words: Aphid, Botanicals, Karanj seed kernel extract, Management, Economics, Micro-arthropods, Neem seed kernel extract, Neem seed kernel powder, Plant parasitic nematode, Root rot

Fodder and nutritional security for livestock population play a vital and catalytical role in Indian farming system and is a compulsive need for the nation. Various natural and cultivated forages provide about 550 million tons of green fodder against the present yearly demand of 900 million tons, indicating a deficit of about 40% (Pathak and Kumar 2004). India has only 4.9% of its cropped area are under fodder cultivation and there is very little scope for its expansion in arable land. The only alternative left is the vertical expansion through its increased crop productivity. In the present situation one of the ways to augment forage production is to reduce the losses inflicted by various pests and diseases. Forage crops are subjected to the depredations of pests and diseases in the same manner as in other

agricultural produce. These pests and diseases hamper crop establishment, impair forage quality and reduce green fodder and seed yield.

The losses in forage crops by the pests collectively amount to the tune of 25–30% (Ahmed *et al.* 1996). The sustainability of the fodder production system largely depend upon overcoming biotic stress factors like insect pests, plant pathogens and plant parasitic nematodes. In major forage crops the quantitative and qualitative losses caused by these biological stress factors have been reviewed (Saxena *et al.* 2002). The major constraint in berseem (*Trifolium alexandrinum* L.) crop production is root rot complex caused collectively by *Rhizoctonia solani* and *Fusarium semitectum*. The association of stunt nematode (*Tylenchorhynchus vulgaris* Linn) further aggravates the disease spread (Ahmed *et al.* 1996). Heavy incidence of disease lowers the plant density thus green forage yield is reduced drastically. In mustard, major insect pest problem is mustard aphid, [*Lipaphis erysimi* (Kalt.)]. (Singh and Sachan 1997). The

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severe incidence of which reduces the forage yield heavily.

Use of pesticides in fodder crops is not only toxic to animals but also produces hazards to the ecosystem. The poor resource mobilizing capacity, inadequate capital restraint and non-availability of the desired pesticides at the right time are major constraints faced by the farmers. The role of eco-friendly approaches has assumed significant importance with the current thrust on organic farming. As botanicals hold promise for the management of insect pests in an environmental friendly way, therefore in the present study, various combinations of botanicals as seed/soil treatments along with their foliar sprays have been evaluated to manage the biotic stress factors in berseem+mustard fodder production.

MATERIALS AND METHODS

The investigation was conducted during 2003–06. A combination of 2 variables: seed/soil treatment (neem seed kernel 50 g/kg seed, Trineem 10 g/kg urea, carbofuran 3 G + carbendazim at 2% w/w - as recommended check and no seed/soil treatment); and botanical sprays 3% neem (*Melia azadiracta*) seed kernel aqueous extract, 3% karanj (*Pongamia pinnata*) seed kernel aqueous extract, endosulfan 35EC 0.07%+ mancozeb 0.09% concentration as recommended check and no spray of the crop. The experiment was in split-plot design with 3 replications. Pre-sowing treatments (seed/soil treatment) were applied in main plots while sprays were in subplots. First spray was given on 30th day after sowing and the rest on 10 day after each cut. Entomological and pathological data were recorded at various crop growth stages as per the pest occurrence and nature. Plant parasitic nematodes and beneficial micro-arthropods data were recorded by taking the soil samples at harvest stage of the crop.

To estimate the aphid population on mustard, 10 plants were tagged randomly in each treatment. In each tagged plant 5 cm terminal shoot tip of each branch was taken for counting aphid population. Before counting the aphids were removed with the help of a camel hairbrush on a white chart sheet and total numbers of aphids were counted. Later average number of aphid per branch was estimated (Singh and Sachan 1997). Disease severity on berseem was recorded as per procedure given by Mayee and Datar (1986). For estimating plant parasitic nematode population 5 samples were collected randomly from 5–10 cm layer of soil from the root zone of the crop and bulked to make one composite sample. From this composite sample nematodes were extracted as per method suggested by Baermann (1917). The extracted nematodes were counted under a microscope and the population of plant parasitic nematodes was estimated. For estimation of beneficial micro-arthropods (Collembolan and mites) soil samples were drawn at harvest. Five samples/plot (15 cm depth) were collected using a Cylindrical Core Sampler (diameter 5 cm). The fauna was extracted by

dynamic extraction method using Berlese-Tullgren Funnel. The fauna were categorized and counted under a binocular stereozoom microscope. Green fodder yield has been recorded at harvest of the crop.

RESULTS AND DISCUSSION

In berseem + mustard crop, incidence of aphid [*Lipaphis erysimi* (Kalt.)] was recorded on mustard in all the plots; however, treated plots showed significantly less incidences. No significant differences were recorded among various treatments. Carbofuran + carbendazim as a seed treatment along with foliar spray of endosulfan + mancozeb recorded minimum damage due to root rot in berseem. Although maximum biotic stress management was achieved in synthetic pesticidal combinations in which a reduction of 68.76% in root rot complex (*Rhizoctonia solani* and *Fusarium semitectum*) intensity in berseem and a reduction of 68.22% aphid population in mustard was recorded. In this treatment an increase of 43.94% green fodder yield was recorded over control. Among various combinations of botanicals, seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract provided maximum protection (a reduction of 68.22% in the root rot intensity in berseem and a reduction of 70.28% aphid population in mustard) consequently an increase of 33.61% in green fodder yield over control (Table 1). Ahmad *et al.* (2000) also reported the efficacy of 3% neem seed kernel extract spray for minimizing the foliar pests and diseases incidence in an intensive fodder production system.

Among various combinations of botanicals seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract provided maximum protection against plant parasitic nematode (*Tylenchorhynchus vulgaris*) (a reduction of 42%). This treatment also harbored maximum number of beneficial soil micro-arthropods, viz *Folsomia* sp. *Brachystomella* sp. *Cryptostigmata* (approximately triple population of beneficial Collembolans and mites in comparison with untreated check).

Among various combinations of treatments it was observed that minimum population of plant parasitic nematodes (1 176 average/unit area) have been recorded in carbofuran + carbendazim as a seed treatment along with foliar spray of endosulfan + mancozeb. Among various combinations of botanicals experimented the minimum plant parasitic nematode population (1 428 average/unit area) was recorded in seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract (3%) treatment (Table 1).

The population of the total biota was found highest in the neem seed kernel package, followed by soil treatment with Trineem and neem seed kernel extract spray. Applications of Trineem and neem seed kernel have significantly built-up the saprophytic mite's population over the years. This indicated that the botanical seed treatment doses were non-toxic to untargeted organisms. The botanical based plant protection packages in general supported

Table 1 Effect of botanical treatments on pest complex, soil biota and green forage yield in mustard+ berseem mixed crop (pooled data for 2003–06)

Treatment	Mustard	Berseem	PPN Population	Beneficial micro-arthropods		Yield (tonnes/ha) (4 cuts)
	Aphid (nos.)	Root rot		Mites	Collembola	
T ₁ (carbofuran + carbendazim 2%, w/w) + neem seed kernel extract spray (3%)	25.06	3.47	1192	60.25	5.25	87.30
T ₂ (carbofuran + carbendazim 2%, w/w)+ karanj seed kernel (3%) spray	32.52	3.88	1192	64.25	3.75	82.88
T ₃ (carbofuran + carbendazim 2% w/w) + [endosulfan (0.07%)+ mancozeb (0.09%)]	23.74	2.88	1176	39.50	2.75	91.36
T ₄ (carbofuran + carbendazim 2%, w/w) + no spray	58.59	4.36	1192	49.75	14.25	76.58
T ₅ neem seed kernel powder 50 g/kg seed+ neem seed kernel extract(3%) spray	22.20	5.00	1424	137.75	15.25	84.80
T ₆ neem seed kernel powder 50 g/kg seed + karanj seed kernel extract (3%) spray	30.13	5.89	1416	47.50	11.25	76.99
T ₇ neem seed kernel powder 50 g/kg seed+ [endosulfan (0.07%) + mancozeb (0.09%)]	17.19	4.22	1424	59.75	3.00	86.98
T ₈ neem seed kernel powder 50 g/kg seed+ no spray	58.41	6.49	1416	86.50	4.00	69.07
T ₉ trineem + neem seed kernel extract (3%) spray	23.70	6.64	1392	103.02	4.25	91.23
T ₁₀ trineem + karanj seed kernel extract (3%) spray	33.42	7.49	1376	77.00	5.00	84.05
T ₁₁ trineem + [endosulfan (0.07%) + mancozeb (0.09%)]	20.53	5.77	1344	62.75	6.50	93.99
T ₁₂ trineem + no spray	57.82	7.22	1352	114.25	5.00	76.84
T ₁₃ no seed/soil treat + neem seed kernel extract (3%) spray	29.81	6.16	2392	67.75	11.50	76.65
T ₁₄ no seed/soil treat + karanj seed kernel extract (3%) spray	46.94	7.58	2392	77.50	8.75	69.81
T ₁₅ no seed/soil treat + [endosulfan (0.07%) + mancozeb (0.09%)]	29.99	5.00	2504	57.50	4.00	76.97
T ₁₆ no seed/soil treat + no spray	74.70	9.22	2456	51.00	4.75	63.47
CD (<i>P</i> =0.05)	9.05	1.17	48.0	7.40	1.08	7.05

PPN, Plant parasitic nematode

significantly higher soil biota in comparison to no treatment and chemical control measures.

Among various combinations of treatments, it was observed that maximum populations of beneficial micro-arthropods (137.75 of mites and 15.25 of collembolans/unit area) were recorded in seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract treatment. While least numbers of both the beneficial micro-arthropods (39.50 mites and 2.75 collembolans/unit area) was recorded in treatment carbofuran + carbendazim as a seed treatment along with foliar spray of endosulfan + mancozeb (Table 1). This suggests the sustainability of the system through the

use of botanicals without interrupting with the ecosystem. Thus under the umbrella of organic farming aptness of neem for the affluence of soil health is worthy.

The insecticidal and feeding deterrent properties of neem have been established by a number of workers in India (Jotwani and Srivastava 1981 and Shah 1995). Faruqui and Saxena (2000) reported that neem seed kernel extract was capable of reducing germination of conidia of zonate leaf spot of sorghum, uredospores of *Uromyces striatus* and oospores of *Perenospora trifolii*. Shah (1995) reported the effectiveness of neem as a feeding deterrent to rangeland grasshoppers. In conformity to the results presented in this

Table 2 Economics of various botanical treatments

Treatment	Total production	Gross returns	Cost of cultivation	Net returns	Cost of production of green fodder yield ₹/100 kg	Benefit: cost ratio (F= B/C)
	(tonne/ha) (A)	(₹/ha) (B)	(₹/ha) (C)	(₹/ha) (D= B-C)	(E=C/A)	
T ₁ (carbofuran + carbendazim 2%, w/w) + neem seed kernel extract spray (3%)	87.30	69 840	35 596	34 243	40.77	1.96
T ₂ (carbofuran + carbendazim 2%, w/w)+ karanj seed kernel (3%) spray	82.88	66 304	35 173	31 130	42.44	1.89
T ₃ (carbofuran + carbendazim 2% w/w) + [endosulfan (0.07%)+ mancozeb (0.09%)]	91.36	73 088	36 815	36 272	40.3	1.99
T ₄ (carbofuran + carbendazim 2%, w/w) + no spray	76.58	61 264	32 633	28 630	42.61	1.88
T ₅ neem seed kernel powder 50 g/kg seed+ neem seed kernel extract(3%) spray	84.08	67 840	35 055	32 784	41.34	1.94
T ₆ neem seed kernel powder 50 g/kg seed + karanj seed kernel extract (3%) spray	76.99	61 592	33 455	28 136	43.45	1.84
T ₇ neem seed kernel powder 50 g/kg seed+ [endosulfan (0.07%) + mancozeb (0.09%)]	86.98	69 584	36 322	33 261	41.76	1.92
T ₈ neem seed kernel powder 50 g/kg seed+ no spray	69.07	55 256	30 686	24 569	44.47	1.80
T ₉ trineem + neem seed kernel extract (3%) spray	91.23	72 984	35 920	37 063	39.37	2.03
T ₁₀ trineem + karanj seed kernel extract (3%) spray	84.05	67 240	34 679	32 560	41.26	1.94
T ₁₁ trineem + [endosulfan (0.07%) + mancozeb (0.09%)]	93.99	75 192	37 319	37 872	39.71	2.01
T ₁₂ trineem + no spray	76.84	61 472	32 433	29 038	42.21	1.90
T ₁₃ no seed/soil treat + neem seed kernel extract (3%) spray	76.05	60 840	35 565	25 274	46.77	1.71
T ₁₄ no seed/soil treat + karanj seeds kernel extract (3%) spray	69.81	55 848	31 799	24 048	45.55	1.76
T ₁₅ no seed/soil treat + [endosulfan (0.07%) + mancozeb (0.09%)]	76.97	61 528	34 046	27 481	44.23	1.81
T ₁₆ No seed/soil treat + no spray CD (P=0.05)	63.47	51 016	29 489	21 526	46.46	1.73

finding, a number of workers have earlier reported successful use of neem preparations in controlling insect-pests including locusts and grasshoppers of various crops (Jotwani and Srivastava 1981, and Shah 1995).

The economics of various botanicals experimented revealed that maximum net return was in treatment Trineem (pre-sowing) and 3% neem seed kernel extract as spray (post-sowing), followed by Trineem (pre-sowing) and 0.07% endosulfan + 0.09% mancozeb as spray (post-sowing) where cost : benefit ratio of 2.03 and 2.01 was worked out. Seed coating with neem seed kernel powder + sprays of 3% neem seed kernel extract provided a cost : benefit ratio of 1.94 (Table 2). Pandey *et al.*

(2000) also reported a higher net benefit ratio in an IPM with neem seed kernel extract (3%) spray for the management of insect pests and diseases in an intensive fodder production system.

The research outcome suggests the aptness of botanicals for the management of major insect pests, diseases and plant parasitic nematodes along with affluence of soil health if the crop is managed under the umbrella of organic farming. The economics of using botanicals also works out to be adequate in low value commodity, like forage crops. Thus the present findings strongly advocate the array of botanicals in general and neem in particular for pest management in an organic agriculture.

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