The Pharma Innovation Journal 2022; 11(9): 2057-2062

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 2057-2062

www.thepharmajournal.com
Received: 04-06-2022
Accepted: 06-07-2022

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Management of linseed rust (*Melampsora lini* (Ehrenb.) Lev. by cultural (Alteration of sowing dates and spacing), biological and chemicals means

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Abstract
Present study was conducted for management of rust of linseed by alteration in date of sowing and spacing on rust severity, grain yield and effect of botanicals, plant extracts, cow urine and chemicals. The study reveals that management of rust of linseed by cultural method with three dates of sowing and four row to row spacing, D_2 (9^{th} November) was the best environment as rust disease severity was very low (11.50%) while in third date of sowing D_3 (19^{th} November) rust disease severity was high (17.0%). Thus, late sowing of linseed crop increased the disease severity. Wider spacing of 40 cm showed minimum disease severity (5.66%) and maximum grain yield of 807.68 Kg/ha while closer spacing (25cm) resulted in maximum disease severity (25.11%) and minimum grain yield (552.96 Kg/ha). Interaction between sowing date & spacing revealed that treatment having D_3S_1 *i.e.* 19^{th} November sown crops at 25 cm spacing showed higher rust severity (26.67%) and minimum seed yield (521.68 Kg/ha) while D_2S_4 having 9^{th} November sown crops with 40 cm spacing showed minimum rust severity (2.33%) and maximum seed yield (822.68 Kg/ha). Management of linseed rust using plant extracts, Garlic bulb extract @ 10% was highly effective giving minimum rust severity (17.33%) and maximum grain yield (816.7 Kg/ha) with 1.08:1 B:C ratio. Biocontrol agent *Trichoderma harzianum* @ 0.5% was moderately effective in controlling the disease (33.52%) with grain yield of 691.7 Kg/ha. Cow urine @ 0.5% and *Pseudomonas fluorescens* was least effective (26.52%) & (17.34%) in controlling the disease severity. In field trial on effect of fungicides, the treatment (T_2) having Propiconazole @ (0.1%) showed minimum rust severity 4.9 per cent and maximum grain yield 867.29 Kg/ha with B:C ratio of 1.23:1.

Keywords: Disease severity, biocontrol agents, plant extracts, fungicides

Introduction
Linseed (*Linum usitatissimum* L.) commonly known as Tisi or Alsi, is a multipurpose *Rabi* oilseed crop, cultivated for oil and fiber, belongs to the family Linaceae having 14 genera. The name *Linum* is originated from the Celtic word lin or "thread" and the name *usitatissimum* is Latin for "most useful". It is believed that flax is originated in the Middle East or Indian regions. Two morphologically distinct cultivated types of linseed are recognized, namely flax and linseed. The flax type is commercially grown for the extraction of fiber, whereas the linseed is meant for the extraction of oil from seeds and cake as a by-product. Linseed contains about 36 to 48% oil content which has been a rich source of two essential fatty acids, alpha-linolenic acid (Lorgeril *et al*., 1999) [17] and linoleic acid (Bloedon and Szapary, 2004) [8]. Edible linseed oil is used for human consumption and contains alpha -linolenic acid (ALA), a poly unsaturated fatty acid that has nutritional and health benefits (Neil and Alister, 2003) [24]. It has drying and hardening properties which is emanated from its high linolenic acid content, thus it is mostly used for industrial purposes such as manufacturing of paints, varnishes, soaps and printing inks (Wakjira, 2007) [40]. Flax fiber has good strength, light weight and gaining momentum as key ingredient in the manufacturing industry *i.e.* used for the production of paper, coarse textiles, rope, fiber board, molded panels and insulation material.
World over, linseed is an important crop grown over 26.01 lakh ha with production of 25.65 lakh tonnes with average productivity of 986 Kg/ha, while In India production of 1.525 lakh tonnes is from 172.71 lakh ha with productivity of 574 Kg/ha. In India, linseed is cultivated in Madhya Pradesh (38000 ha), Uttar Pradesh (28000 ha), Chattisgarh (17760 ha), Odisha (11560 ha), Bihar (8200 ha) and Assam (4760 ha). Bihar ranks first in productivity (849 Kg/ha) followed by M.P (712 Kg/ha), UP (631 Kg/h) and Odisha (483 Kg/ha). In Jharkhand, the crop is grown in 39770 ha area with a production of 19530 tonnes and 491 Kg/ha productivity (Anonymous, 2019) [4].

Linseed is known to be attacked by many pathogens like fungi, bacteria, mycoplasmas, viruses and other abiotic causes which limit the production and productivity of the crop. Among them, rust of linseed caused by *Melampsora lini* is a serious threat to the cultivation of the crop in Jharkhand. Although, the disease can be managed by chemicals but new chemicals need to be evaluated.

Rust

Rust caused by *Melampsora lini* (Ehrenb.) Lev. is of wide occurrence and has been reported almost from all linseed growing countries. *M. lini* was first described by Persoon (1801) [25] under the name *Uredo miniata* var. *Lini* Pers. In India, its occurrence was reported for the first time by Butler (1914) [41]. It was of common occurrence in United Provinces (now parts of Madhya Pradesh and Uttar Pradesh) (Prasada, 1940) [42]. The disease was in epiphytotic form in Indogangetic Plains in Northern India during 1961 (Hora *et al*., 1962) [13]. Rust is now a serious problem in Jammu & Kashmir, Northern hills of Himachal Pradesh and Uttar Pradesh, adjacent part of Punjab, Bihar, West Bengal, Odisha and certain parts of Uttar Pradesh (Gill, 1987) [11].

Yield losses

The yield losses from rust have been estimated by several workers in the country under naturally infected as well as under artificial conditions (Chauhan and Srivastava, 1976; Misra, 1979; Shukla, 1992) [9, 21, 9]. The disease was found to cause 16-100 and 70-100 per cent yield losses in moderately to highly susceptible varieties but no loss in resistant varieties (Hora *et al*., 1962) [13]. The disease not only causes the yield loss but also damages the fibre quality and oil contents. In light infection there is no loss in oil content but in heavy infection, it is reduced by 10-34% (Srinivasachar and Seetharaman, 1971) [34]. Singh *et al*. (1978) [30] found 13.1 per cent loss in oil content in heavily infected linseed variety artificially infected with *M. lini*. Light to moderate infections reduced yield 34-55% and severe infections reduced it 64-79% (Hoes and Dorrel, 1979) [12]. Agrawal and Kotasthane (2009) [2] reported that linseed rust caused loss upto 50 per cent in yield. The yield losses due to rust ranged from 8.9 to 87.3% being maximum in variety Chambal (87.3%) followed by 52.6% in R-552, 45.2% in T-397, 43.6% in J-23, 39.5% in kiran, 26.8% in kangra local and minimum 8.9% in Nagarkot (Kumar, 2016) [14].

Symptoms

The symptoms of rust in linseed caused by *Melampsora lini* appeared as pycnial, aecial, uredinial and telial stages. The pycnia were small, pale, inconspicuous although numerous globoid, subepidermal, and without ostiolar filaments. The aecia were caeoma form without peridia rather pale, and not as prominent as the uredinia. The uredinia occured as orange-yellow pustules on all green parts of the plant, especially on the leaves and the telia were most conspicuous on the main stem and branches, where they formed black, usually swollen, incrustations, although they also occured on leaves, sepals and bolls (Arthur, 1906) [5]. The rust attacked all the aerial parts of the plant in the form of bright yellow or orange uredopustules on both surfaces of leaves, which might be extended to stem and capsules. The heavily affected leaves gave a scorched appearance (Vasudeva, 1962) [39]. The light-yellow to orange-yellow sori containing pycnia and aecia on leaves and stems early in the growing season, followed by reddish-yellow uredia on leaves, stems and capsules during the growing season and later, brown to black telia covered by the epidermis, chiefly on the stems (Laundon and Waterston, 1965) [16]. The uredia which occur in large numbers on both the surfaces of the leaves and other aerial parts of the plant and brown to black telia appear as crusts covered by the epidermis (Mehrotra, 2003) [19].

Materials and Methods

Field trial was conducted during *Rabi* season 2019-20 with sowing dates and spacing in split plot design using sowing dates as main plot and spacing as sub plot in three replications. The linseed variety T-397 was sown with three dates *i.e*. 31st October, 9th November and 19th November and four spacing *viz*., 25 cm, 30 cm, 35 cm and 40 cm.

The Biological trial was conducted during *Rabi* 2019-20 at Research farm of Birsa Agricultural University, Kanke, Ranchi to study the efficacy of bio- agents, plant extracts and fresh cow urine on rust disease management in linseed. Linseed variety T-397 was sown on 9th November in plot size of 1.5m X 4m with a row spacing of 30 cm in three replications using Randomised Block Design. Fertilizer dose of 30 Kg N, 20 Kg P_2O_5, 20 Kg K_2O and 20 Kg S per hectare was used in the experiment. Commercial formulation of *Trichoderma harzianum, Pseudomonas fluorescens* and Neem oil each at 0.5% concentration was used as a foliar spray just after initiation of disease symptoms. Crude extracts (2:1) of onion and garlic bulb was prepared at the time of spray and 10% concentration of the extracts was used. Fresh cow urine was taken and it was diluted to 5%.

The crop was first sprayed with the known concentration of plant products and bio-agents just after initiation of the symptoms. Water sprayed plot served as control. The second spray was given 14 days after first spray. Final observation on rust severity was taken on 3rd April, 2020. The yield data was taken after harvest of the crop.The data were statistically analyzed.

The Chemical trial was conducted during *Rabi* 2019-20 at Research farm of Birsa Agricultural University Kanke, Ranchi to study the efficacy of fungicides on rust disease management in linseed. Linseed variety T-397 was sown on 13th December 2019 in plot size of 2.4m×3m with a row spacing of 30 cm in three replication using Randomised Block Design. Fertilizer dose of 30 Kg N, 20 Kg P_2O_5, 20 Kg K_2O and 20 Kg S per hectare was used in the experiment. For evaluation of fungicides in field condition, the crop was sprayed with freshly prepared rust inoculum to create artificial epiphytotics during evening hours on 29th February 2020. Water was sprayed on the crop next day to maintain the humidity. Commercial formulation of Mancozeb @ 0.25%, Propiconazole @ 0.1% and Nativo @ 0.05% concentration was used as a foliar spray just after initiation of disease symptoms.

The crop was first sprayed with the known concentration of fungicides just after initiation of the symptoms. The unsprayed plot served as control. The second spray was given 15 days after first spray. Final observation on rust severity was taken on 5th April 2020. The yield data was taken after harvest of the crop. The data were statistically analyzed.

Results and Discussion

Effect of date of sowing on rust severity and yield of linseed

Table 1: Effect of date of sowing on rust severity and yield of linseed

Date of sowing	*Yield (Kg/ha)	*Disease Severity (%)
D_1	667.76	15.42 (22.53)
D_2	725.72	11.50 (18.12)
D_3	658.06	17.00 (23.61)
SEm (±)	28.39	0.94
CD (P=0.05)	111.46	3.70
CV %	14.38	15.24

*Average of three replications
Figures in parentheses are transformed arc sine values
D_1 = 31st October 2019, D_2 = 09th November 2019, D_3 = 19th November 2019

Linseed crop sown on 9th November (D_2) recorded lowest rust disease severity of 11.50 per cent and highest grain yield of 725.72 Kg/ha. This treatment was followed crop sown on 31st October (D_1) which recorded rust disease severity of 15.42 per cent and linseed grain yield of 667.76 Kg/ha whereas, highest rust disease severity of 17.00 per cent was recorded when crop sown on 19th November (D_3) this treatment also recorded linseed grain yield of 658.06 Kg/ha as sown in Table 1.

Effect of spacing on severity and yield of linseed

Table 2: Effect of spacing on severity of linseed rust

Spacing	*Yield (Kg/ha)	*Disease Severity (%)
S_1	552.96	25.11 (30.00)
S_2	647.68	18.11 (25.05)
S_3	727.07	9.67 (17.50)
S_4	807.68	5.66 (13.14)
SEm (±)	29.00	0.96
CD (P=0.05)	86.15	2.86
CV %	12.72	13.50

*Average of three replications
Figures in parentheses are transformed arc sine values
S_1 = 25 cm, S_2 = 30 cm, S_3 = 35 cm, S_4 = 40 cm

Table 2 showed that the lowest linseed rust disease severity of 5.66 per cent was recorded when row to row spacing of linseed was 40 cm (S_4). This treatment recorded highest grain yield of 807.84 Kg/ha. This treatment was followed by S_3 (row to row spacing of 35 cm) which recorded rust disease severity of 9.67 per cent and linseed grain yield of 727.07 Kg/ha. The next best treatment in order to superiority was S_2 (row to row spacing of 30 cm) which recorded rust disease severity of 18.11 per cent and linseed grain yield of 647.68 Kg/ha. Highest linseed rust disease severity of 25.11 per cent was recorded when row to row spacing of linseed was 25 cm (S_1) and lowest linseed grain yield of 552.96 Kg/ha.

Interaction between date of sowing and spacing on rust severity and yield of linseed

Table 3: Interaction between date of sowing and spacing on rust severity and yield of linseed

Date × Spacing	*Yield (Kg/ha)	*Disease Severity (%)
D_1S_1	545.35	25.33 (30.18)
D_1S_2	650.18	17.33 (24.41)
D_1S_3	724.43	10.67 (18.91)
D_1S_4	751.10	8.33 (16.63)
D_2S_1	591.68	23.33 (28.81)
D_2S_2	679.35	15.67 (23.27)
D_2S_3	809.18	4.67 (11.94)
D_2S_4	822.68	2.33 (8.47)
D_3S_1	521.68	26.67 (31.01)
D_3S_2	613.51	21.33 (27.46)
D_3S_3	705.68	13.67 (21.66)
D_3S_4	791.18	6.33 (14.31)
SEm (±)	50.22	1.67
CD (P=0.05)	149.20	4.96
CV %	12.72	13.50

*Average of three replications, Figures in parentheses are transformed arc sine values
D_1 = 31st October, 2019, S_1 = 25 cm, D_2 = 09th November, 2019, S_2 = 30 cm, D_3 = 19th November, 2019, S_3 = 35 cm, S_4 = 40 cm

It is evident from the Table 3 that linseed crop sown on 9th November having row to row spacing 40 cm (D_2S_4) recorded highest grain yield of 822.68 Kg/ha and lowest rust disease severity of 2.33 per cent. This treatment was followed by crop sown on 9th November having spacing of 35 cm (D_2S_3) recorded rust disease severity of 4.67 per cent and linseed grain yield of 809.18 Kg/ha. The next better treatment was (D_3S_4) *i.e.*, the crop sown on 19th having spacing 40 cm (row to row) which recorded disease severity of 6.33 per cent and linseed grain yield of 791.18 Kg/ha. Highest rust disease severity of 26.67 per cent was recorded when crop sown on 19th November and row to row spacing of 25 cm (D_3S_1). This treatment also recorded lowest linseed grain yield 521.68 Kg/ha.

Linseed crop sown on 9th November, 2019 (D_2) recorded lowest rust disease severity of 11.50 per cent and highest grain yield of 725.72 Kg/ha whereas, highest rust disease severity of 17.00 per cent was recorded when crop sown on 19th November 2019 (D_3). This treatment also recorded linseed grain yield of 658.06 Kg/ha. Incidence of rust in respect of sowing dates in linseed was not reported by other workers. But it finds similarity in observation on crops like field pea and lentil. Sangar and Singh (1994) [28] reported that delayed sowing of pea cultivars after 15th October, increased the incidence of *U. viciae-fabae* infestations and decrease grain yield. Bhardwaj and Sharma (1996) [7] noticed that rust (*U. viciae-fabae*) infection was delayed by 8 to 10 days in pea crop sown in mid-season on 18 October as compared to early (September) late sowing (November). Singh *et al*. (1996) [33] reported that that incidence of rust (*U. viciae-fabae*) increased but grain yield decreased as sowing was delayed in three pea cultivars. Mittal (1997) [23] observed that sowing of lentil crop on 19th October was most effective in reducing the disease and increasing yield of lentil than late sown crop where rust incidence was high. Singh *et al*. (2012) [31] noticed that least rust severity when pea was planted on October 15th whereas, highest rust severity was recorded on late sown crop (November 14th, 29th and December 13th). Highest grain yield was recorded when there was least disease incidence. Upadhyay *et al*. (2018) [37] reported that early sown crop in 31st October, 7th and 14th November, faced lower disease severity (8.67-17.50%) and produce good yield (690.90-775.39 Kg/ha). But crop sown on 21st November, 28th November, 5th and 12th December succumb to high disease severity (40-54.17%) with low yield (429.06-581.95 Kg/ha). These observations were in accordance with the present findings.

Lowest linseed rust disease severity of 5.66 per cent was recorded when wider row to row spacing of linseed was 40 cm (S_4) and highest grain yield of 807.68 Kg/ha. Whereas, highest linseed rust disease severity of 25.11 per cent was recorded when narrow row to row spacing of linseed was 25 cm (S_1) and lowest linseed grain yield of 552.96 Kg/ha. Mengesha and Tesfaye (2015) [20] noticed that the spacing was varied significantly in disease incidence and severity. The maximum yield of garlic was obtained from plot planted with 10 cm intra row spacing where was the minimum value of yield was recorded at plot planted with 20 cm intra row spacing. The results explained that increasing intra-row spacing from 10 to 20 cm decreased disease incidence and severity simultaneously increasing the yield of garlic. Ahmed *et al.* (2017) [3] noticed that plant spacing had significant impact on the occurrence of rust disease and its severity, yield and yield components. Planting of garlic with 10 cm spacing had more disease incidence (79%) and disease severity (55.66%). Plants with 20 cm spacing had least disease incidence (67%) and disease severity (45.33%). The findings about the row to row spacing were in accordance with the findings of Mengesha and Tesfaye (2015) [20] and Ahmed *et al.* (2017) [3].

Linseed crop sown on 9th November having wider row to row spacing 40 cm (D_2S_4) recorded highest grain yield of 822.68 Kg/ha and lowest rust severity of 2.33 per cent whereas highest rust disease severity of 26.67 per cent was recorded when crop sown on 19th November and narrow row to row spacing of 25 cm (D_3S_1) and lowest linseed grain yield 521.68 Kg/ha. Lal *et al.* (2007) [15] noticed that earliest sown of lentil crop (15th October) showed maximum disease severity (51.0%). As sowing delayed, disease gradually decreased in severity of lentil rust caused by *Uromyces viciae-fabae* declined gradually on row to row spacing increased. Maximum disease severity (47.0%) was observed in 15cm spacing while 35cm spacing showed minimum rust severity (24.75%). Singh *et al*. (2014) [32] noticed that field pea sown on 13th December recorded the highest disease severity and minimum grain yield. It was also noticed that planting geometry *i.e* row spacing has significant influence on rust severity. The minimum disease severity was recorded in plots having wider row spacing (45 cm) followed by 37.5 and 30 cm. The findings about alteration of sowing date and row to row spacing was in conformity with the findings of Lal *et al.* (2007) [15] and Singh *et al.* (2014) [32].

Table 4: Effect of bio- agents, plant extracts and cow urine on severity of rust and yield of linseed

Treatments		Dose (%)	*Disease Severity (%)	Disease control over check (%)	*Yield (Kg/ha)	Increase in yield over control (%)	B:C ratio
T_1	*Trichoderma harzianum*	0.5	38.33 (38.20)	33.52	691.7	18.57	1.11:1
T_2	*Pseudomonas fluorescens*	0.5	47.66 (43.63)	17.34	641.7	10	0.94:1
T_3	Neem oil	0.5	34.66 (36.04)	39.88	755.6	29.5	1.13:1
T_4	Garlic bulb extract	10	17.33 (24.53)	69.94	816.7	40.0	1.08:1
T_5	Onion bulb extract	10	20.66 (26.98)	64.16	794.4	36.2	1.41:1
T_6	Cow urine	5	42.33 (40.52)	26.58	661.1	13.3	1.06:1
T_7	Control (only water spray)		57.66 (49.51)		583.3		
SEm (±)			2.072		44.95		
CD (P=0.05)			6.456		138.01		
CV %			9.687		11.01		

*Average of three replications

Figures in parentheses are transformed arc sine values

The application of garlic bulb extract at 10% showed minimum rust disease severity of 17.33 per cent having maximum grain yield of 816.7 Kg/ha and benefit cost ratio was 1.08:1 whereas highest rust severity of 47.66 per cent was observed in treatment (T_2) *Pseudomonas fluorescens* having minimum grain yield of 641.7 Kg/ha and its benefit cost ratio was 0.94: 1. Tripathi and Rathi (2003) [35] noticed that none of biocontrol agents (*Trichoderma virens*, *Trichoderma viride* and *Pseudomonas fluorescens*) were effective in reducing the rust severity in pea. But in present investigation *Trichoderma harzianum* was moderately effective but *Pseudomonas fluorescens* was least effective. Mishra *et al.* (2017) [22] noticed that neem leaf extract was found to be effective to controlling rust disease of pea. Minimum per cent disease incidence (30.80) was recorded from this plot. Two foliar sprays of neem leaf extract at interval of 10 days might be the option for the management of rust disease in severe condition. Reddy *et al.* (2020) [27] noticed that Neem oil (5%), Castor oil (5%), Clove oil (5%), *Trichoderma viride* (5%), *T. viride* + Neem oil (2.5%+2.5%), *T. viride* + Castor oil (2.5%+2.5%) and *T. viride* + Clove oil (2.5%+2.5%) were found to be significantly superior over control in managing the rust disease and also in increasing the growth parameters. They also noticed that *T. viride* + Neem oil (2.5%+2.5%) having 27.77 per cent PDI followed by Neem oil (5%) and *Trichoderma viride* (5%) which had 25.57 per cent PDI were significantly superior over other treatments in managing rust disease of the crop and also in increasing the growth parameters. The findings about managing rust severity by using of bioagents and plant extracts was in conformity with the findings of Tripathi and Rathi (2003) [35], Mishra *et al.* (2017) [22] and Reddy *et al.* (2020) [27]. The references on managing of linseed rust by using of Garlic extract, Onion extract and Cow urine are not available.

Table 5: Effect of fungicides on severity of linseed rust and yield of linseed

	Treatments	*Disease Severity (%)	Disease control over check (%)	*Yield (Kg/ha)	Increase in yield over control (%)	B:C ratio
T_1	Two foliar spray(FS) of Mancozeb (0.25%)	15.2 (22.9)	51.12	777.78	16.1	0.98:1
T_2	Two foliar spray(FS) of Propiconazole (0.1%)	4.9 (12.7)	84.24	867.29	29.5	1.23:1
T_3	Two foliar spray (FS) Nativo (0.05%)	20.1 (26.8)	35.36	705.25	5.3	0.60:1
T_4	First FS of Mancozeb (0.25%) at disease initiation followed by 2nd FS of Propiconazole (0.1%) after 15 days after 1st FS	7.9 (15.9)	74.59	811.94	21.2	1.08:1
T_5	First FS of Mancozeb (0.25%) at disease initiation followed by 2nd FS of Nativo (0.05%) after 15 days after 1st FS	16.2 (23.7)	47.90	740.74	10.6	0.78:1
T_6	First FS of Propiconazole (0.1%) at disease initiation followed by 2nd FS of Nativo (0.05%) after 15 days after 1st FS	12.6 (20.5)	59.48	807.12	20.5	0.94:1
T_7	First FS of Propiconazole (0.1%) at disease initiation followed by 2nd FS of Mancozeb (0.25%) after 15 days after 1st FS	6.0 (14.0)	80.70	851.85	27.2	1.18:1
T_8	Control	31.1 (34.4)		669.75	-	
	SEm (±)	1.83		27.74		
	CD (P=0.05)	5.7		86.0		
	CV %	15.4		16.3		

***** Average of three replications, Figures in parentheses are transformed arc sine values

Table 5 indicated that the application of Propiconazole @ (0.1%) showed minimum rust disease severity 4.9 per cent having maximum grain yield of 867.29 Kg/ha and benefit cost ratio was 1.23: 1 whereas highest rust disease severity of 20.1 per cent was observed in treatment (T_3) Nativo @ (0.05%) having minimum grain yield of 705.25 Kg/ha and its benefit cost ratio was 0.60: 1. Vir and Grewal (1964) [38] reported that the Parzate with zinc sulphate to control linseed rust when sprayed four times at fortnightly intervals reduced the infection to traces. Agrawal and Kotasthane (1970) [1] noticed that the pretreatment of seed with organo- mercurial fungicide at 1 g/kg, and using seed stored in the warm plains during summer for hill sowing were effective for control of linssed rust. Upadhyaya and Verma (1972) [36] reported that that, In field trials, Dithane S-41 and RH 539 (Ni sulphate and Dithane M-22) were more effective than Wettable sulphur in controlling rust disease. Fraland and Littlefield (1972) [10] effectively controlled the rust by using of systemic fungicides, 4-amino-6 chloro-2(methylthio) (U-8342) and Oxycarboxin when applied as eradicants 5- days after inoculation and seed dressing with Oxycarboxin or soil drench with 7-8342 were also effective. Raut and Somani (1988) [26] reported that the best control of linseed rust was obtained with 2% Bayleton (triadimefon) giving 63% control, followed by Calixin (tridemorph) giving 57%. Barnwal *et al.* (2011) [6] noticed that application of *Trichoderma viride* (Tv) @ 4 g/kg of seed as seed treatment and spray of Ridomil MZ @ (0.15%) (a combination product of mancozeb -64%+ metalyxl-8%) as fungicides recorded rust disease incidence 12.3 per cent with grain yield of (8.4 q/ha) and B:C ratio of 1:3.82 and seed treatment with thiophanate methyl @ 2 g/kg seed plus single spray of Ridomil MZ @(0.15%) and recorded rust disease incidence of 14.6 per cent with grain yield 7.9 (q/ha) and B:C ratio of 1:1.29. The efficacy of Manocozeb @ (0.25%), Propiconazole@ (0.1%), Nativo@ (0.05%) and their combination which was highly effective in present investigation were not taken by earlier workers. But, Trizole fungicides like Bayleton and tridemorph was also highly effective in earlier experiment (Raut and Somani, 1988) [26].

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