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## Field efficacy of ready mix combination of Penflufen 154 + Trifloxystrobin 154 - 308 FS (w/v) against seed and seedling rot diseases of cotton

**Bhattiprolu SL****Abstract**

Efficacy of ready mix combination of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) was tested at three doses of 15.4 + 15.4 gai /100kg, 30.8 + 30.8 gai/100kg and 46.2 + 46.2 gai/100kg in comparison with Penflufen 154, Trifloxystrobin 154 each at 46.2 gai/100kg, Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg), Thiram 75WS (225 gai/100kg) at Regional Agricultural Research Station, Lam, Guntur, during 2014 and 2015 against seed and seedling rot diseases of cotton variety Narasimha. Germination and plant stand at 14 days after sowing and seedling vigour at 28 days were best in 46.2 + 46.2 gai/100kg with highest control of Alternaria leaf spot (58.34%) and increased yields (77.77%) without phytotoxicity. Highest benefit cost ratio was also obtained with 46.2 + 46.2 gai/100kg (1.33) followed by 30.8 + 30.8 gai/100kg (1.25) and Carboxin + Thiram (1.22) as against 0.80 in untreated control.

**Keywords:** Cotton, penflufen, trifloxystrobin, seed borne diseases, seedling rot

**Introduction**

Cotton is an important commercial crop in India with a production of 377 lakh bales of 170 kg lint in 2017-2018 from an area of 122.35 lakh ha with a productivity of 524 kg/ha, which is far behind the leading countries. Andhra Pradesh stood 7<sup>th</sup> in area (5.44 lakh ha) but 5<sup>th</sup> in production (22.0 lakh bales) and 3<sup>rd</sup> in productivity (688 kg/ha) during 2017-2018 (Anonymous, 2018) <sup>[1]</sup>. Seed and seedling rot diseases affect germination and cause seedling mortality. Several pathogens including *Xanthomonas axonopodis* pv *malvacearum*, *Alternaria macrospora*, *A. alternata*, *Colletotrichum capsici*, *Rhizoctonia solani*, *Fusarium oxysporum* f. sp. *vasinfectum* are associated as seed and/or soil borne in cotton. Importance of seed treatments in sustainable agriculture was reviewed by Sharma *et al* (2015) <sup>[2]</sup>. Seed treatment with thiram @ 3g or carboxin @ 2g or captan @ 3g or carbendazim @ 2g was recommended and validated to manage these pathogens in cotton (Anonymous 2016) <sup>[3]</sup>. In order to explore the possibility of the use of new chemicals with broad spectrum activity, ready mix combination of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) was evaluated against seed and seedling rot diseases of cotton variety Narasimha.

**Materials and Methods**

Cotton variety, Narasimha was raised in plots of 31.5 sq. m adopting a spacing of 105cm x 60cm at Regional Agricultural Research Station, Lam, Guntur, during *kharif* 2014 and 2015. Seed treatments were imposed at the time of sowing in randomized block design as detailed below:

Treatment details for Bio efficacy

Treatments	Dosage/100kg seed	
	g.a.i./100kg	Formulation (g/ml/100kg seed)
T <sub>1</sub> Untreated control		
T <sub>2</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	15.4 + 15.4	100
T <sub>3</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	30.8 + 30.8	200
T <sub>4</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	46.2 + 46.2	300
T <sub>5</sub> Penflufen 154	46.2	190
T <sub>6</sub> Trifloxystrobin 154	46.2	93
T <sub>7</sub> Carboxin 37.5% WP + Thiram 37.5% DS	131.25 + 131.25	350
T <sub>8</sub> Thiram 75% WS	225	300

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Data on germination percentage at 14 and 21 days after sowing (DAS), plant stand at 28 and 42 DAS was recorded. Data on seed borne diseases was collected by adopting 0-4scale (Raj, 1988) [4]: 0 = No disease; 1 = <5%; 2 = 6-20%; 3 = 20-40% and 4 = >40% leaf area is diseased. Depending on the scores collected percent disease intensity (PDI) was calculated using the formula of Wheeler (1969) [5]:

$$PDI = \frac{\text{Sum of all the numerical ratings}}{\text{Total number of leaves scored} \times \text{Maximum disease grade}} \times 100$$

Percent disease control in each treatment was calculated. Recommended protection measures against insect pests were

taken on need basis. Yield data from three replications of each treatment was recorded. Decrease / increase in the disease/ yield over control were calculated using the formula:

$$\frac{T - C}{C} \times 100 \text{ where}$$

T = PDI or yield (q/ha) of respective treatment

C = PDI or yield of control

Treatment wise Benefit Cost Ratio (BCR) was calculated by dividing gross returns with gross expenditure.

Treatment details for phytotoxicity

Treatments	Dosage/100kg seed	
	g.a.i./100kg	Formulation (g/ml/100kg seed)
T <sub>1</sub> Untreated control		
T <sub>2</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	46.2 + 46.2	300
T <sub>3</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	92.4 + 92.4	600
T <sub>4</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS	184.8 + 184.4	1200

Number of leaves showing phytotoxicity symptoms along with total number of leaves, on 10 randomly selected plants at 14 days after germination (DAG), 21DAG and 28DAG were recorded. Phytotoxicity percentage was calculated and treatments were graded on 1-10 scale:

Phytotoxicity Scale

S. No	Scale	Phytotoxicity (%)
1	0 Scale	No phytotoxicity
2	1 Scale	1 – 10% phytotoxicity
3	2 Scale	11 – 20% phytotoxicity
4	3 Scale	21- 30% phytotoxicity
5	4 Scale	31 – 40% phytotoxicity
6	5 Scale	41 – 50% phytotoxicity
7	6 Scale	51 – 60% phytotoxicity
8	7 Scale	61 – 70% phytotoxicity
9	8 Scale	71 – 80% phytotoxicity
10	9 Scale	71 – 90% phytotoxicity
11	10 Scale	81 – 100% phytotoxicity

## Results and Discussion

Germination was significantly superior at 14DAS in Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg) (T<sub>4</sub>-85.33%) during 2014. Other treatments, viz., Trifloxystrobin 154 (T<sub>6</sub>-74.67%), Penflufen 154 (T<sub>5</sub>-73.33%), Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg) (T<sub>7</sub>-72.67%), Thiram (T<sub>8</sub>-71.33%), Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg) T<sub>3</sub>-69.0%) and Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg) (T<sub>2</sub>-65.33%) were statistically on par

as against control (61.0%). All the three test doses of Penflufen 154 + Trifloxystrobin 154 – 308 FS (T<sub>4</sub>, T<sub>3</sub> and T<sub>2</sub> with 94.34%, 91.82% and 90.57% germination, respectively), Carboxin 37.5% WP + Thiram 37.5 % DS (T<sub>7</sub>-91.19%) and Penflufen 154 (T<sub>5</sub>-87.42%) were statistically on par during 2015 (Table 1). Pooled data on germination revealed that germination was significantly superior at 14DAS in T<sub>4</sub>, Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg) (89.84%) while other treatments viz., Carboxin 37.5% WP + Thiram 37.5 % DS (T<sub>7</sub>-81.93%), Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg) (T<sub>3</sub>-80.41%), Penflufen 154 (T<sub>5</sub>-80.38%), Trifloxystrobin 154 (T<sub>6</sub>-80.10%), Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg) (T<sub>2</sub>-77.95%) and Thiram (T<sub>8</sub>-77.17%) respectively, were statistically on par as against control (67.29%). However at 21 DAS germination in treatments was numerically better (93.24% to 97.39% and 90.83% to 96.67%) than untreated control (90.14% and 83.33%) during 2014 and 2015, respectively (Table 1). Pooled data also showed highest germination (97.03%) with T<sub>4</sub> followed by T<sub>7</sub> (96.36%), T<sub>3</sub> (95.08%), T<sub>5</sub> (94.92%), T<sub>2</sub> (93.71%), T<sub>6</sub> (93.43%) and T<sub>8</sub> (93.19%). Tomer *et al.* (2012) [6] obtained 63.96% to 68.77% germination by protecting against seed borne *Myrothecium roridum*, *Aspergillus niger* and *Curvularia lunata* in J 4 cotton cultivar. Maximum seed germination per cent and minimum mortality per cent (5.70%) was recorded with seed treatment of carboxin 37.5% + thiram 37.5% DS @ 4.5 g/kg seed against seedling diseases of cotton caused by *Rhizoctonia solani* and *Fusarium sp.* (Rajani, *et al.*, 2018) [7].

**Table 1:** Evaluation of ready mix combination of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) against seed and seedling rot diseases of cotton

Treatment	Germination (%) at 14DAS			Germination (%) at 21DAS			Seedling Vigour at 28DAS		
	2014-15	2015-16	Mean	2014-15	2015-16	Mean	2014-15	2015-16	Mean
T <sub>1</sub> Untreated control	61.00 <sup>fg</sup>	73.58 <sup>h</sup>	67.29 <sup>h</sup>	90.14	83.33	86.74	5108.23	4357.32 <sup>b</sup>	4732.78 <sup>g</sup>
T <sub>2</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg)	65.33 <sup>bcdefg</sup>	90.57 <sup>abcd</sup>	77.95 <sup>bcdef</sup>	93.24	94.17	93.71	5875.05 <sup>a</sup>	5415.14 <sup>a</sup>	5645.10 <sup>abcdef</sup>
T <sub>3</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg)	69.00 <sup>bcdef</sup>	91.82 <sup>ab</sup>	80.41 <sup>bc</sup>	95.15	95.00	95.08	5963.05 <sup>a</sup>	5704.94 <sup>a</sup>	5834.00 <sup>ab</sup>
T <sub>4</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg)	85.33 <sup>a</sup>	94.34 <sup>a</sup>	89.84 <sup>a</sup>	97.39	96.67	97.03	6219.22 <sup>a</sup>	5974.40 <sup>a</sup>	6096.81 <sup>a</sup>

T <sub>5</sub>	Penflufen 154 (46.2 gai/100kg)	73.33 <sup>bc</sup>	87.42 <sup>abcde</sup>	80.38 <sup>bcd</sup>	97.34	92.50	94.92	6114.90 <sup>a</sup>	5488.81 <sup>a</sup>	5801.86 <sup>abc</sup>
T <sub>6</sub>	Trifloxystrobin 154 (46.2 gai/100kg)	74.67 <sup>b</sup>	85.52 <sup>bcdef</sup>	80.10 <sup>bcde</sup>	96.02	90.83	93.43	6016.75 <sup>a</sup>	5422.28 <sup>a</sup>	5719.52 <sup>abcd</sup>
T <sub>7</sub>	Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg)	72.67 <sup>bcd</sup>	91.19 <sup>abc</sup>	81.93 <sup>b</sup>	96.89	95.83	96.36	5716.51 <sup>a</sup>	5614.75 <sup>a</sup>	5665.63 <sup>abcde</sup>
T <sub>8</sub>	Thiram 75WS (225 gai/100kg)	71.33 <sup>bcde</sup>	83.00 <sup>defg</sup>	77.17 <sup>bcdef</sup>	95.54	90.83	93.19	5700.87 <sup>a</sup>	5404.37 <sup>a</sup>	5552.62 <sup>bcdef</sup>
	SEM $\pm$	3.21	2.63	2.31	2.39	4.56	1.90	171.49	186.74	152.40
	CD at 5%	9.73	7.97	7.01	NS	NS	NS	520.13	566.39	462.25
	CV (%)	7.7	5.2	5.0	4.3	8.5	3.5	5.1	6.0	4.7

\*The figures indicated with same alphabet are not significantly different.

Seedling vigour was statistically superior in all the treatments, highest being in Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg) during 2014 and 2016. Pooled data indicated superior seedling vigour (6095.81) with Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg); T<sub>3</sub> (5834.00), T<sub>5</sub> (5801.86), T<sub>6</sub> (5719.52), T<sub>7</sub> (5665.63) and T<sub>2</sub> (5645.10) were statistically on par with T<sub>4</sub> (Table 1).

No phytotoxicity symptoms were observed in plants treated with the three doses of test product. It can be inferred that the combination product, Penflufen 154 + Trifloxystrobin 154 – 308 FS does not cause any phytotoxicity at the three doses tested.

All treatments significantly reduced *Alternaria* leaf spot during 2014 and 2015 at 14 DAS (Table 2). Lowest intensity of *Alternaria* leaf spot (4.33%) was recorded with T<sub>4</sub>, Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg) during 2014-15 followed by 30.8 + 30.8 gai/100kg (T<sub>3</sub>-4.67%) and Carboxin+Thiram (T<sub>7</sub>-4.67%). During 2015-16 intensity of *Alternaria* leaf spot was lowest (3.0%) in T<sub>4</sub> and T<sub>7</sub> followed by T<sub>2</sub> (3.33%). Pooled data at 14 DAS revealed that T<sub>4</sub> recorded the lowest intensity of *Alternaria* leaf spot (3.67%) and T<sub>7</sub> (3.84%), T<sub>3</sub> (4.00%) and T<sub>2</sub> (4.34%) were statistically on par with T<sub>4</sub>. At 28 DAS all treatments reduced *Alternaria* leaf spot during 2014 and 2015 (Table 2). Lowest intensity of *Alternaria* leaf spot (6.00%) was recorded with T<sub>4</sub> during 2014-15 followed by T<sub>3</sub> (6.67%), T<sub>2</sub> (7.00%), T<sub>7</sub> (7.67%), T<sub>5</sub> (7.67%) and T<sub>6</sub> (8.00%) and were statistically on par. During 2015-16 intensity of *Alternaria* leaf spot was lowest (3.00%) in T<sub>7</sub> and T<sub>4</sub> (3.67%) followed by T<sub>3</sub> (4.33%) which were on par. Pooled data at 28 DAS revealed that T<sub>4</sub> recorded the lowest intensity of *Alternaria* leaf spot (4.84%); T<sub>7</sub> (5.34%), T<sub>3</sub> (5.50%), T<sub>2</sub> (5.84%) and T<sub>5</sub> (6.50%) were statistically on par with T<sub>4</sub>.

Reduction in *Alternaria* leaf spot at 42 DAS was observed in all treatments during 2014 and 2015 (Table 2). Lowest intensity of *Alternaria* leaf spot (7.33%) was recorded with T<sub>4</sub>

during 2014-15 while T<sub>3</sub> (9.67%), T<sub>7</sub> (11.00%) and T<sub>2</sub> (11.33%) were statistically on par with T<sub>4</sub>. During 2015-16 intensity of *Alternaria* leaf spot was lowest (5.0%) in T<sub>4</sub> and other treatments, T<sub>3</sub> (5.33%), T<sub>2</sub> (6.00%) and T<sub>7</sub> (6.67%) were statistically on par with T<sub>4</sub>. Pooled data at 42DAS revealed that T<sub>4</sub> recorded the lowest intensity of *Alternaria* leaf spot (6.17%) followed by T<sub>2</sub> (7.5%) and were statistically superior to other treatments. Tomer *et al* (2012) [6] observed that carboxin @ 2g/kg was highly effective in controlling the seed borne pathogens. Ebadollah Baniyani *et al* (2015) [8] recommended Goucho and carboxin-thiram, Larvin and carboxin-thiram for seed disinfection cotton. Oktay Erdogan *et al* (2016) [9] found that vitavax was very effective against *Rhizoctonia solani* and *Fusarium* sp. with highest germination (76.1%) in cotton cultivar carman. Eisa (Nawal) *et al* (2005) [10] recorded that Vitawax-T 70 (carboxin+thiram 70%) and Vitawax-T40 (carboxin+thiram 40%) were the best seed treatments against root pathogens in cotton cultivars Giza-86 and Giza-89 with increased yields. Asghar Heydari (2015) [11] observed that delinting with 98% acid was more effective against *Rhizoctonia solani* causing seed decay (rot) and seedling damping-off in Sahel and Varamin cotton varieties in Iran. Seed delinting with 80 and 60% acid and seed treatment with carboxin-thiram fungicide also significantly reduced the disease incidence in comparison with linted seeds. Carboxin + thiram @ 0.2% was found most effective against seed borne fungal infections including *A. alternata*, *Fusarium* sp. and *Xanthomonas axonopodis* pv *malvacearum* by rolled towel method and controlled *Alternaria* blight in field (Hanasi, 2013) [12]. Combination of carboxin 37.5% WP + thiram 37.5% DS 4.5g/kg resulted in lowest mortality (4.11%) and lowest intensity of *Alternaria* leaf spot (4.11%) with maximum yield of 9.65q/ha (Bhattiprolu, 2017) [13]. *In vitro* sensitivity of *Alternaria alternata* causing tobacco brown spot to azoxystrobin was observed by Hancheng Wang *et al.* (2016) [14].

**Table 2:** Efficacy of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) against *Alternaria* leaf spot of cotton

Treatment	Alternaria leaf spot (Percent Disease Intensity)									
	14DAS			28DAS			42DAS			
	2014-15	2015-16	Mean	2014-15	2015-16	Mean	2014-15	2015-16	Mean	
T <sub>1</sub>	Untreated control	8.33 <sup>b</sup> (16.74)	6.33 <sup>b</sup> (14.54)	7.33 <sup>c</sup> (15.58)	14.33 <sup>c</sup> (22.22)	7.67 <sup>d</sup> (16.06)	11.00 <sup>c</sup> (19.37)	16.00 <sup>b</sup> (23.58)	13.33 <sup>d</sup> (21.39)	14.67 <sup>c</sup> (22.51)
T <sub>2</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg)	5.00 <sup>a</sup> (12.92)	3.67 <sup>a</sup> (11.02)	4.34 <sup>a</sup> (11.97)	7.00 <sup>a</sup> (15.34)	4.67 <sup>bc</sup> (12.46)	5.84 <sup>a</sup> (13.94)	11.33 <sup>a</sup> (19.64)	6.00 <sup>abc</sup> (14.18)	8.67 <sup>b</sup> (17.11)
T <sub>3</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg)	4.67 <sup>a</sup> (12.46)	3.33 <sup>a</sup> (10.47)	4.00 <sup>a</sup> (11.54)	6.67 <sup>a</sup> (14.95)	4.33 <sup>abc</sup> (11.97)	5.50 <sup>a</sup> (13.56)	9.67 <sup>a</sup> (18.10)	5.33 <sup>ab</sup> (13.31)	7.50 <sup>a</sup> (15.89)
T <sub>4</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg)	4.33 <sup>a</sup> (11.97)	3.00 <sup>a</sup> (9.98)	3.67 <sup>a</sup> (11.02)	6.00 <sup>a</sup> (14.19)	3.67 <sup>ab</sup> (11.02)	4.84 <sup>a</sup> (12.66)	7.33 <sup>a</sup> (15.68)	5.00 <sup>a</sup> (12.92)	6.17 <sup>a</sup> (14.36)
T <sub>5</sub>	Penflufen 154 (46.2 gai/100kg)	5.33 <sup>a</sup> (13.31)	4.00 <sup>a</sup> (11.54)	4.67 <sup>b</sup> (12.46)	7.67 <sup>a</sup> (16.06)	5.33 <sup>c</sup> (13.31)	6.50 <sup>a</sup> (14.77)	12.00 <sup>b</sup> (20.27)	7.67 <sup>c</sup> (16.06)	9.84 <sup>b</sup> (18.24)
T <sub>6</sub>	Trifloxystrobin 154 (46.2 gai/100kg)	5.67 <sup>a</sup> (13.75)	4.33 <sup>c</sup> (11.97)	5.00 <sup>b</sup> (12.92)	8.00 <sup>a</sup> (16.43)	5.67 <sup>c</sup> (13.75)	6.84 <sup>b</sup> (15.12)	13.33 <sup>b</sup> (21.39)	8.33 <sup>c</sup> (16.74)	10.83 <sup>b</sup> (19.19)
T <sub>7</sub>	Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg)	4.67 <sup>a</sup> (12.46)	3.00 <sup>a</sup> (9.98)	3.84 <sup>a</sup> (11.24)	7.67 <sup>a</sup> (16.06)	3.0 <sup>a</sup> (9.98)	5.34 <sup>a</sup> (13.31)	11.00 <sup>a</sup> (19.37)	6.67 <sup>ab</sup> (14.95)	8.84 <sup>b</sup> (17.26)

T <sub>8</sub>	Thiram 75WS (225 gai/100kg)	5.67 <sup>a</sup> (13.75)	4.00 <sup>a</sup> (11.54)	4.84 <sup>b</sup> (12.66)	10.33 <sup>b</sup> (18.72)	5.33 <sup>c</sup> (13.31)	7.83 <sup>b</sup> (16.22)	12.67 <sup>b</sup> (20.84)	7.0 <sup>bc</sup> (15.34)	9.84 <sup>b</sup> (18.24)
	SEM ±	0.61	0.47	0.32	0.92	0.54	0.57	1.36	0.63	0.81
	CD at 5%	1.85	1.43	0.97	2.78	1.64	1.74	4.11	1.92	2.46
	CV (%)	19.4	20.6	11.7	18.9	18.9	14.8	20.1	15.0	14.8

\*Figures in parentheses are transformed values. The figures indicated with same alphabet are not significantly different.

Plant stand was numerically superior in all treatments in comparison to control during 2014 while T<sub>4</sub>, T<sub>3</sub>, T<sub>2</sub> and T<sub>7</sub> resulted in statistically significant plant stand during *khariif* 2015 at 28DAS. At 42 DAS, plant stand was numerically superior in all treatments in comparison to control during 2014 and 2015 (Table 3).

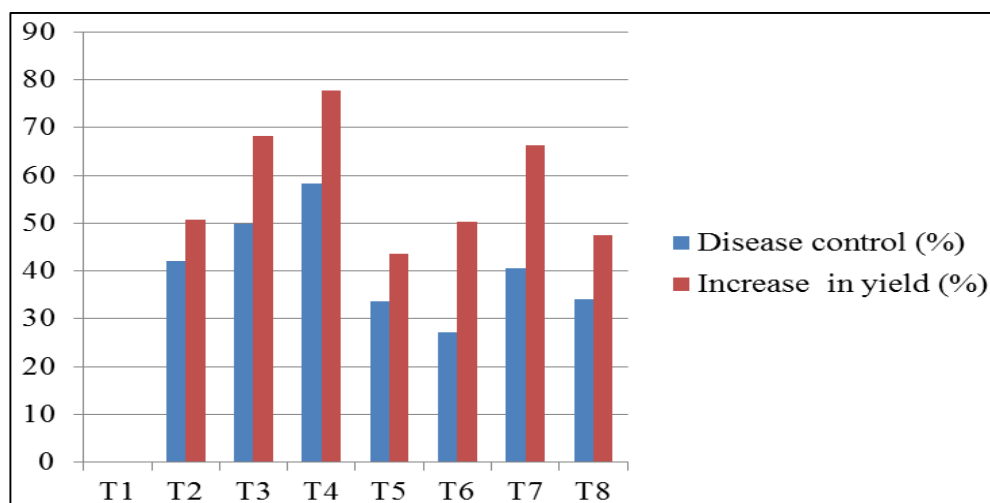
Seed cotton yield was statistically superior to control during 2014 (17.17q/ha) and 2015 (8.48q/ha) in all the treatments (Table 3). Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg) (T<sub>4</sub>) recorded the highest yield of 24.60q/ha and other treatments *viz.*, T<sub>6</sub> (24.50q/ha), T<sub>3</sub> (23.00q/ha), T<sub>7</sub> (22.00q/ha), T<sub>2</sub> (21.87q/ha) and T<sub>5</sub> (21.40q/ha) were at par with T<sub>4</sub> during 2014. Highest yield of 18.0q/ha was also obtained with T<sub>4</sub> during 2015 followed by T<sub>6</sub> (17.33q/ha) and T<sub>3</sub> (17.17q/ha) which were statistically on par. Pooled data on seed cotton yield revealed that T<sub>4</sub> yielded highest (21.30q/ha) followed by T<sub>3</sub> (20.09q/ha), T<sub>7</sub> (19.67q/ha) and T<sub>6</sub> (18.95q/ha) which were statistically on par. Untreated control plot recorded 12.83q/ha. Seed treatment followed by foliar spray

with strobilurin fungicide treatments significantly increased pearl millet yields (Sudisha *et al.*, 2005) [15]. Increase in germination, population and yield was observed in maize seed infected fungal pathogens (Solorzano and Malvick, 2011) [16]. Maximum disease control was obtained in T<sub>4</sub> (54.19% and 62.49%) followed by T<sub>3</sub> (39.56% and 60.12%) and T<sub>7</sub> (31.25% and 49.96%) during 2014 and 2015 respectively (Table 4). Pooled data also showed that disease control was maximum in T<sub>4</sub> (58.34%) followed by T<sub>3</sub> (49.84%) and T<sub>7</sub> (40.61%) (Fig.1). During 2014 maximum increase in yield of 43.27% was obtained with T<sub>4</sub> followed by T<sub>6</sub> (42.69%) and T<sub>2</sub> (33.95%) while maximum yield increase was also with T<sub>4</sub> (112.26%) followed by T<sub>7</sub> (104.36%) and T<sub>2</sub> (102.48%) during 2105. Pooled data revealed that maximum yield increase was also with T<sub>4</sub> (77.77%) followed by T<sub>2</sub> (68.22%) and T<sub>7</sub> (66.25%) (Fig.1). Highest gross returns of Rs 87330/- were recorded with T<sub>4</sub> followed by T<sub>2</sub> (Rs 82369/-) and T<sub>7</sub> (Rs 80647/-).

**Table 3:** Evaluation of Ready mix combination of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) against seed and seedling rot diseases of cotton

Treatment	Plant Stand at 28DAS			Plant Stand at 42DAS			Seed Cotton Yield (q/ha)			
	2014-15	2015-16	Mean	2014-15	2015-16	Mean	2014-15	2015-16	Mean	
T <sub>1</sub>	Untreated control	35	30.67 <sup>e</sup>	32.84 <sup>e</sup>	61	39.33	50.17	17.17 <sup>c</sup>	8.48 <sup>e</sup>	12.83 <sup>e</sup>
T <sub>2</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg)	43.67	39.0 <sup>ab</sup>	41.34 <sup>a</sup>	67	48.33	57.67	21.87 <sup>a</sup>	14.77 <sup>bcd</sup>	18.32 <sup>b</sup>
T <sub>3</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg)	44.67	39.67 <sup>a</sup>	42.17 <sup>a</sup>	68.67	49.00	58.84	23.00 <sup>a</sup>	17.17 <sup>abc</sup>	20.09 <sup>a</sup>
T <sub>4</sub>	Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg)	45	41.67 <sup>a</sup>	43.34 <sup>a</sup>	87.67	50.33	69	24.60 <sup>a</sup>	18.00 <sup>a</sup>	21.30 <sup>a</sup>
T <sub>5</sub>	Penflufen 154 (46.2 gai/100kg)	42	36.00 <sup>bc</sup>	39.00 <sup>a</sup>	74	46.67	60.34	21.40 <sup>a</sup>	13.77 <sup>d</sup>	17.59 <sup>b</sup>
T <sub>6</sub>	Trifloxystrobin 154 (46.2 gai/100kg)	40	34.67 <sup>cd</sup>	37.34 <sup>b</sup>	76.67	44.00	60.34	24.50 <sup>a</sup>	13.40 <sup>d</sup>	18.95 <sup>a</sup>
T <sub>7</sub>	Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg)	41	38.33 <sup>a</sup>	39.67 <sup>a</sup>	75	48.33	61.37	22.00 <sup>a</sup>	17.33 <sup>ab</sup>	19.67 <sup>a</sup>
T <sub>8</sub>	Thiram 75WS (225 gai/100kg)	46	34.33 <sup>cd</sup>	40.17 <sup>a</sup>	74.67	42.33	58.5	20.93 <sup>b</sup>	14.67 <sup>cd</sup>	17.80 <sup>b</sup>
	SEM ±	3.19	1.13	1.65	4.98	3.05	3.0	1.21	0.85	0.81
	CD at 5%	NS	3.44	5.00	NS	NS	NS	3.68	2.59	2.46
	CV (%)	13.0	5.3	7.2	12	11.5	8.8	9.6	10.0	7.7

\*The figures indicated with same alphabet are not significantly different.



**Fig 1:** Efficacy of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) in cotton.

Benefit cost ratio (BCR) of different seed treatments varied between 1.09 and 1.33 as against 0.80 in untreated control (Table 4). Highest benefit cost ratio was also obtained with 46.2 + 46.2 gai/100kg (1.33) followed by 30.8 + 30.8 gai/100kg (1.25) and Carboxin 37.5% WP + Thiram 37.5 % DS (1.22).

### Conclusion

The ready mix ready mix combination of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) at 46.2 + 46.2 gai/100kg

and 30.8 + 30.8 gai/100kg increased per cent germination, seedling vigour without any phytotoxicity and is cost effective against seed borne pathogen *i.e.*, *Alternaria macrospora* and contributed to increase in seed cotton yield followed by Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg). Hence it can be included in seed treatment schedule under integrated disease management of *Alternaria* leaf spot of cotton.

**Table 4:** Efficacy of Penflufen 154 + Trifloxystrobin 154 – 308 FS (w/v) against seed and seedling rot diseases of cotton

Treatment	Disease Control (%)		Increase in yield (%)		Gross expenditure	Gross returns	Benefit cost ratio (BCR)
	2014-15	2015-16	2014-15	2015-16			
T <sub>1</sub> Untreated control	-	-	-	-	65875	52603	0.80
T <sub>2</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (15.4 + 15.4 gai/100kg)	29.19	54.99	27.37	74.17	65883	75112	1.14
T <sub>3</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (30.8 + 30.8 gai/100kg)	39.56	60.12	33.95	102.48	65891	82369	1.25
T <sub>4</sub> Penflufen 154 + Trifloxystrobin 154 – 308 FS (46.2 + 46.2 gai/100kg)	54.19	62.49	43.27	112.26	65898	87330	1.33
T <sub>5</sub> Penflufen 154 (46.2 gai/100kg)	25.00	42.46	24.64	62.38	65880	72119	1.09
T <sub>6</sub> Trifloxystrobin 154 (46.2 gai/100kg)	16.69	37.51	42.69	58.02	65880	77695	1.18
T <sub>7</sub> Carboxin 37.5% WP + Thiram 37.5 % DS (131.25 + 131.25 gai/100kg)	31.25	49.96	28.13	104.36	65876	80647	1.22
T <sub>8</sub> Thiram 75WS (225 gai/100kg)	20.81	47.49	21.90	73.0	65877	72980	1.11

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