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Effectiveness of various eco-friendly treatments comprising of cultural practices and neem based botanicals against shootfly (*Atherigona pulla* Wiede) in little millet var Birsa Gundli 1

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Abstract

A study was undertaken at little millet research plot of Birsa Agricultural University, Kanke, Ranchi during *Kharif* season of 2017, in order to ascertain the effect of different eco-friendly treatments comprising of cultural practices and neem based botanicals against shootfly infesting little millet i.e. variety Birsa Gundli 1. Cultural practices like 1.5 times of recommended seed rate and early sowing like 15 days before normal sowing were taken as treatments. And there were three botanicals and one chemical insecticides with control. Seed treatment with insecticide before the sowing the crop and one spray were applied of botanical in each treatment for which first spray was done at 7 days after germination of the crop and second was repeated after 15 days of first spray. Spraying of 1500 ppm neem /azadiractin application should be applied at seventh day after sowing which gave maximum grain yield and minimum incidence of shootfly. However, highest cost benefit ratio was obtained with seed treatment with chlorpyrifos 20 EC @ 2.5 ml/kg of seed.

Keywords: Little millet, Shootfly, *Atherigona soccata*, cultural practices, NSKE

Introduction

Little millet is cereal crop belongs to the grass family, Graminae or Poacea. The term "millet" is used to refer several types of small seeded annual grasses. In India, they are cultivated on an area of 131.7 thousand hectares with production of 0.4 million tonnes with a productivity of 578 kg per ha. India is the largest producer of many kinds of millets. However, realizing the nutrient composition of these crops they are now considered as nutri-cereals. Little millet is rich in nutrients and considered as essential food nutritional security and it is a good source of Protein (7.7g), very rich in carbohydrate (67.0g), Fat (4.79g), Calcium (17mg), phosphorus (220mg) and Iron (6.0mg) for each 100g. Shootfly is a dominant pest among several pests attacking the little millet (Jotwani and Sukhani, 1968) ^[5]. Nearly 32 per cent of the crop is lost due to insect pests in India (Borad and Mittal, 1983) ^[4]. Shoot flies (*Atherigona pulla* Wiede) ranks first among the insect pests that attacks little millet, often resulting in heavy loss in the crop yield (Anonymous, 1991) ^[1].

Vedamoorthy *et al.* (1965) ^[9] reported that foliar applications of carbaryl and endrin were much less effective in controlling shootfly than the seed and seed-furrow application of phorate and other insecticides. Mote and Jadhav (1993) reported that the extract of *Azadiracta indica*, *Argemone mexicana* and *Calotropis gigantean* were effective in reducing the level of shootfly in sorghum. Katole *et al.* (2000) ^[6] studied the performance of some IPM modules against *H. armigera* on chickpea. The efficacy of 5 per cent neem seed extract (NSE + 5% cow dung + 5% NSE + 5% cow dung + 5% cow urine, 5% NSE + 0.035% endosulfan, 5% NSE, 5% cow dung, 5% urine and 0.035% endosulfan were evaluated. Pooled data revealed that all the treatments except 5% cow dung and 5% cow urine were effective over the control. Treatment with 5% NSE + 0.035% endosulfan and 5% NSE alone gave the lowest pod damage (13.37 and 16.11%) and the highest average grain yields (8.40 and 7.77 q/ha). Spraying of neem leaf extract at 7 DAE was recorded 39.7 per cent dead hearts was on par with carbofuran 3G whorl application (35.0%) (Anonymous 2001) ^[2].

Neem seed kernel extract (50%) spray at 40 SAE with seed treatment with cruiser (3g/kg seed) and timely sowing recorded least per cent dead hearts (42.98%) and was comparable with farmer practice *i.e.*, timely sowing (80.23%) (Anonymous, 2004) [3]. Singh and Batra (2001) [8] studied the bioefficacy of different neem formulations along with recommended insecticide endosulfan in forage sorghum against shoot fly. The data revealed that eggs per plant and deadhearts due to shoot fly were significantly lesser in all the treatments than that in control. Minimum oviposition (0.6 egg/plant) was recorded in neem treated treatment followed by endosulfan (1.3 egg/plant) and was maximum (7.1 egg/plant) in water spray (control). Minimum deadhearts were recorded in endosulfan (10.5%) followed by neem graded (18.5%), Maximum recorded in control (56%) followed by neem leaf extract (46%).

Materials and methods

Field experiments were conducted at little millet research plot of Birsa Agricultural University, Kanke, Ranchi during *Kharif* season of 2017 in randomized block design with three replication having plot size 3m x 3m to ascertain the efficacy of different insecticides and botanicals against shootfly infesting little millet. The seeds of the little millet variety

Birsa Gundli 1 were sown on 29 June in 2017. All the plots received similar agronomical practices till harvesting. Nine treatments including control were taken for the study. There were three botanicals and one chemical. Seed treatment with insecticide before the sowing the crop and one spray were applied of botanical in each treatment for which first spray was done at 7 days after germination of the crop and second was repeated after 15 days of first spray. The first spray was done on 14 July, 2017. Treatment details are given in Table-1 and cost details are given in Table -2.

Table 1: Treatments details

Treatments	Particulars
T ₁	1.5 times of recommended seed rate
T ₂	Early sowing <i>i.e.</i> 15 days before the normal sowing
T ₃	Spraying of 1500ppm neem/azadirachtin at 7 DAS
T ₄	Spraying of 1500ppm neem/azadirachtin at 15 DAS
T ₅	Foliar application of neem oil 3% at 15 DAS
T ₆	Spraying of NSKE 5% at 7 days after sowing
T ₇	Spraying of NSKE 5% at 15 days after sowing
T ₈	Seed treatment with chlorpyrifos 20EC @ 2.5 ml/kg of seed
T ₉	Control (untreated)

Table 2: Details of insecticides cost and seed cost

Insecticides/seed	Formulation	Dose/ha	Cost of/litre	Source
Neem/azadirachtin	1500ppm	1.125litre/ha	Rs. 260/litre	Local market
Neem oil 3%	3%	15 litre/ha	Rs.120/litre	Local market
NSKE 5%	5%	25 litre/ha	Rs.128/litre	Local market
Chlorpyrifos 20EC	20 EC	2.5ml/kg of seed	Rs. 448/litre	Local market and Isagro (Asia) Agrochemical Pvt. Ltd.
Water	-	500-700 lit. /ha	-	-
Seed Rs20/kg	-	10-12kg/ha	Rs. 200-Rs. 300/ha	Local market
Labour	-	-	Rs. 330/day	-
Sprayer equipment	-	-	Rs. 120/day	Local market

Observations recorded

Weakly observation of egg per plant and dead heart per cent of shootfly infesting little millet were recorded per one row from each plot by predetermined stratified random sampling method from 14 DAE. The mean number of egg per plant, dead heart per cent and number of productive tillers was subjected to analysis of variance. The data were subjected to square root transformation and angular transformation (as per data) before analysis except, yield. The percentage of dead

hearts was assessed from the ratio of plant with dead heart and the total number of plant multiplied by hundred.

Yield

Yield of little millet from each plot in kg/plot was recorded and finally the values were converted in kg/ha. Mean per cent reduction in dead heart per cent as calculated by using the following formula:

$$\text{Mean \% reduction} = \frac{\text{Mean deadheart \%} - \text{deadheart \% in control plots in treated plots}}{\text{Deadheart \% on in control plots}}$$

Cost benefit ratio

The cost-benefit ratio of each treatment was calculated taking into account the prevailing market price of inputs, produce and the labour wages.

Statistical Analysis

All data were subjected to statistical test of significance. The percentage of insect infestation was transformed into arcsine percentage and square root transformation as per data of deadheart %).

Results and discussion

This experiment was conducted with BG 1 variety of little millet. The variety is of short duration type and is a popular variety among the farmers of Jharkhand. Altogether there were nine treatments comprising cultural practices and

botanicals were evaluated against untreated control. Observation were recorded for plants with shootfly eggs (%), eggs per 10 plants (no.), deadheart (%), productive tillers per plant (no.) and yield (q/ha). The results obtained during the course of experiment have been presented in the following paragraphs.

Eggs per 10 plants at different days interval

The results on efficacy of various treatments comprising cultural methods and botanical are given in Table -3. In the table, number of eggs counts has been presented for 14, 21 and 28 DAE. A perusal of the table indicate that at 14 DAE all the treatments proved to be significantly better than untreated control. The least oviposition *i.e.* eggs deposited per 10 plant was observed in spraying of 1500ppm neem/azadirachtin at 7 days after sowing (3.30 eggs per 10

plants) followed by seed treatment with chlorpyriphos and spraying of 1500ppm neem/azadirachtin at 15 days after sowing, early sowing and foliar application of neem oil (3%) at 15 DAE. However, all of them were at par with each other. The highest (7.6 /10 plants eggs) were recorded in control.

After 21 DAE, the egg count varies from 2.83 to 8.30 per 10 plants. The treatment, spraying 1500ppm neem/azadirachtin with a figure of 2.83 eggs/10 plants still maintained its superiority over early sowing i.e. 15 days before the normal sowing (4.10), spraying of NSKE 5% at 7 DAS (4.53), spraying of NSKE 5% at 15 DAS (4.80) and 1.5 times of recommended seed rate (5.20) but was not better than seed treatment with chlorpyriphos (3.31), spraying of 1500ppm neem/azadirachtin at 15 DAS (3.43) and foliar application of neem oil 3% (3.93) the treatments followed by seed treatment

with chlorpyriphos where the number of eggs deposited was 3.31 per 10 plants. Highest (8.30 eggs/10 plants) was recorded in untreated control.

After 28 DAE, all the treatments offered better protection than untreated control. Spraying of 1500ppm neem/azadirachtin at 7 DAS with 2.80 eggs per 10 plants though maintained its supremacy in reducing egg deposition but was not better than seed treatment with chlorpyriphos (3.30 eggs per 10 plants) and spraying of neem/azadirachtin at 15 DAS (3.32 eggs per 10 plants). Seed treatment with chlorpyriphos and spraying of neem/azadirachtin @ 1500ppm at 15 days after sowing were equally effective as early sowing and spraying of NSKE % at 15 days after sowing in reducing egg deposition. Highest (10.23%) egg deposition was noticed in untreated control.

Table 3: Effect of various treatment on the oviposition by the shootfly in little millet during kharif 2017.

TR. NO.	Treatments	Number of eggs / 10 plant		
		14 DAE	21 DAE	28 DAE
T ₁	1.5 times of recommended seed rate	5.40(2.42)*	5.20(2.38)*	5.60(2.46)*
T ₂	Early sowing i.e. 15 days before the normal sowing	4.23(2.17)	4.10(2.14)	4.53(2.24)
T ₃	Spraying of 1500ppm neem/ azadirachtin at 7 days after sowing	3.30(1.94)	2.83(1.82)	2.80(1.81)
T ₄	Spraying of 1500ppm neem/ azadirachtin at 15 days after sowing	3.80(2.07)	3.43(1.98)	3.30(1.94)
T ₅	Foliar application of neem oil 3% at 15 DAE	4.40(2.21)	3.93(2.10)	4.43(2.22)
T ₆	Spraying of NSKE 5% at 7 days after sowing	4.90(2.32)	4.53(2.24)	5.16(2.37)
T ₇	Spraying of NSKE 5% at 15 days after sowing	5.20(2.38)	4.80(2.30)	4.90(2.32)
T ₈	Seed treatment with Chlorpyriphos 20 EC@ 2.5ml/kg of seed	3.36(2.03)	3.31(1.95)	3.32(1.96)
T ₉	Control (Untreated)	7.66(2.85)	8.30(2.96)	10.23(3.27)
	SEm(±)	0.406	0.411	0.421
	C.D. (5%)	1.229	1.244	1.274
	C.V. (%)	14.884	15.851	14.829

* Figures in parentheses are $\sqrt{X+0.5}$ transformed values.

**Figures in parentheses are arcsine transformed values.

Deadheart per cent at different days interval

The results on the efficacy of various treatments comprising cultural methods and botanicals are given in Table-4. In the table, number of deadheart counts has been presented for 14, 21 and 28 DAE. A perusal of the table indicates at 14 DAE proved to be significantly better than untreated control. Data pertaining to formation of deadhearts indicated that all the treatments registered significant decrease in infestation level as compared to untreated control. The lowest (9.33%) deadhearts formation was observed in 1500ppm at 7 DAS which remained at par chlorpyriphos (10.33%), seed treatment with chlorpyriphos which was however, not better than spraying of 1500ppm neem/azadirachtin at 15 DAS (10.66%) which in its turn remained at par with early sowing i.e. 15 days before the normal sowing (11.53%) The highest (29.66%) deadhearts was recorded in untreated control.

After 21 DAE, the extent of deadhearts registered in different insecticidal and botanical treatments revealed significant differences. All treatments varied significantly in efficacy and proved superior over control which recorded the highest deadhearts of 29.73 per cent. Spraying 1500ppm neem/azadirachtin at 7 DAS had the lowest (9.66%) deadheart and remained at par with seed treatment with

chlorpyriphos (10.63%), foliar application of neem oil 3% (10.66%) and spraying of 1500ppm neem/azadirachtin at 15 DAS (10.73%). The remaining treatments were also significantly better over untreated control (29.73%) and can be arranged in order of merit in efficacy as early sowing i.e. 15 days before the normal sowing (11.66%), spraying of NSKE 5% at 7 DAS (17.66%) and 1.5 times of recommended seed rate (20.86%). The highest (29.73%) of deadhearts was observed in untreated control.

After 28 DAE, data pertaining to formation of deadhearts indicate that all the treatments registered significant decrease in infestation level as compare to untreated control (29.86%). The lowest (9.73%) deadhearts formation was observed in spraying of 1500ppm neem/azadirachtin at 7 DAS which was not better than seed treatment with chlorpyriphos (10.83%) spraying of 1500ppm neem/ azadirachtin at 15 DAS (10.86%), spraying of neem oil 3% at 15 DAS (11.33%) and early sowing (11.73%). The next superior treatment were spraying of NSKE 5% at 15 DAS (17.7%) which at par with 1.5 times of recommended seed rate (20.93%) and spraying of NSKE 5% at 7 DAS (20.86%). The highest (29.86%) of deadhearts percent was observed in untreated control.

Table 4: Effect of various treatment on the deadheart (%) caused by shoot fly, *Atherigona pulla* Weide during Kharif 2017.

TR. NO.	Treatments	Dead heart per cent		
		14 DAE	21 DAE	28 DAE
T ₁	1.5 times of recommended seed rate	20.73(27.06)**	20.86(27.13)**	20.93(27.20)**
T ₂	Early sowing i.e. 15 days before the normal sowing	11.53(19.82)	11.66(19.91)	11.73(20.00)
T ₃	Spraying of 1500ppm neem/ azadirachtin at 7 days after sowing	9.33(17.76)	9.66(18.05)	9.73(18.15)
T ₄	Spraying of 1500ppm neem/azadirachtin at 15 days after sowing	10.66(19.00)	10.73(19.90)	10.86(19.19)
T ₅	Foliar application of neem oil 3% at 15 DAE	13.73(21.72)	10.66(19.00)	11.33(19.64)

T ₆	Spraying of NSKE 5% at 7 days after sowing	17.33(24.58)	17.66(24.80)	20.86(27.86)
T ₇	Spraying of NSKE 5% at 15 days after sowing	20.33(26.78)	20.73(27.06)	17.73(24.88)
T ₈	Seed treatment with Chlorpyrifos 20 EC@ 2.5ml/kg of seed	10.33(18.72)	10.63(19.00)	10.83(19.19)
T ₉	Control (Untreated)	29.66(32.96)	29.73(33.02)	29.86(33.09)
	SEm(±)	1.159	1.116	1.170
	C.D. (5%)	3.505	3.374	3.537
	C.V. (%)	12.581	12.222	12.674

**Figures in parentheses are arcsine transformed values.

Effectiveness of various treatments against shoot fly incidence on number of productive tillers in little millet DAE

Due to the attack of shootfly after the emergence of panicles, tillers of the plant are affected and those tillers will be devoid of the seed. Such condition is seen in case of attack of stem borer in rice where such unproductive tillers are called wild ear head. The results are productive tillers are given in Table-5. A perusal of the data indicated that all the treatments control produce significantly more number of productive tillers per plant. The number of productive tillers recorded

was highest in treatment spraying of 1500ppm neem/azadirachtin at 7 DAS (3.40) and was significantly superior over rest of the treatments. It was followed by spraying of NSKE 5% at 15 DAS which with the fig one of 2.66 also proved its supremacy over the rest of the treatments. Spraying of 1500ppm neem/azadirachtin at 15 DAS though recorded third numerically but was not better than 1.5 times of recommended seed rate, early sowing i.e. 15 days before the normal sowing, foliar application of neem oil 3% at 15 DAS and spraying of NSKE 5% at 15 DAS and spraying of NSKE 5% at 7 DAS.

Table 5: Effectiveness various treatments against shoot fly incidence on number of productive tillers in little millet DAE

Tr. no.	Treatments	Number of productive tillers
T ₁	1.5 times of recommended seed rate	2.00 (8.13)
T ₂	Early sowing i.e. 15 days before the normal sowing	2.00 (8.13)
T ₃	Spraying of 1500ppm neem/azadirachtin at 7 days after sowing	3.40 (10.63)
T ₄	Spraying of 1500ppm neem/azadirachtin at 15 days after sowing	2.06 (8.15)
T ₅	Foliar application of neem oil 3% at 15 DAE	2.00 (8.13)
T ₆	Spraying of NSKE 5% at 7 days after sowing	1.80 (7.71)
T ₇	Spraying of NSKE 5% at 15 days after sowing	1.93 (7.92)
T ₈	Seed treatment with Chlorpyrifos 20 EC@ 2.5ml/kg of seed	2.66 (9.28)
T ₉	Control (Untreated)	1.20 (6.29)
	SEm(±)	0.154
	C.D. (5%)	0.465
	C.V. (%)	12.571

*Figures in parentheses are $\sqrt{X+0.5}$ transformed values

Effectiveness and economics of various eco-friendly treatments comprising of cultural practices and botanicals on yield against shootfly infestation in little millet var. BG 1

The yield of the little millet obtained from various treatments varied from 198 kg per hectare (untreated control) to 688 kg per hectare (spraying of 1500ppm neem/azadirachtin at 7 DAS). The highest (688 kg/ha) yield was recorded from plots where spraying of 1500ppm neem/azadirachtin at 7 DAS was given at sowing. However, it was found to be at par with seed treatment with chlorpyrifos 20 EC, spraying of NSKE 5% at 7 DAS, spraying 1500ppm neem/azadirachtin at 15DAS, spraying of NSKE 5% at 15 DAS, foliar application of neem 3% oil at 15 DAS and 1.5 times of recommended seed rate which gave a yield of 635, 626, 615, 610, 559 and 557 kg per hectare, respectively. The lowest yield was recorded in untreated control (198 kg/ha). (Table-6 and Fig-1)

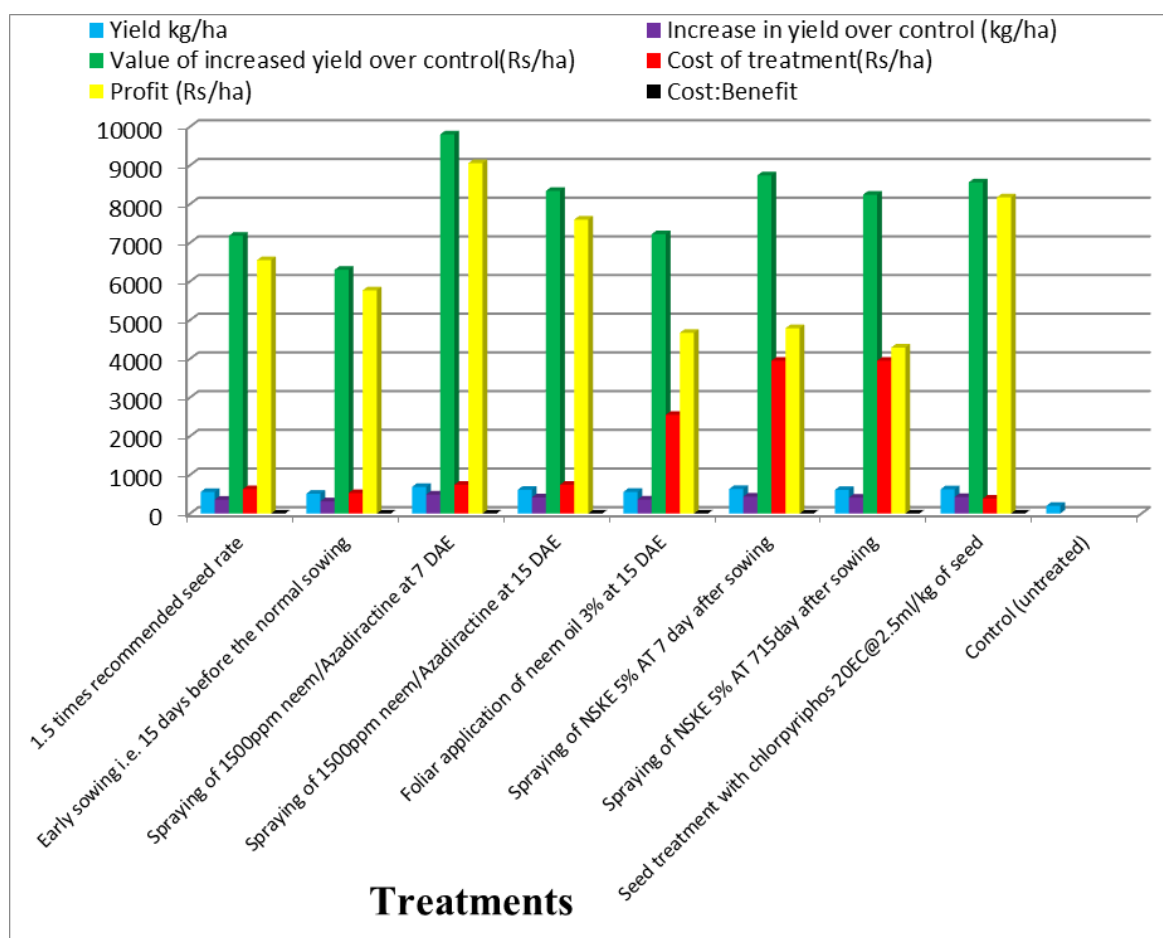
It is evident from the table that the application of various treatments had significant effects in lowering the shootfly infestation and thereby increasing seed yield over untreated control. If we consider increase/decrease in yield due to the application of treatments over control, it may be seen that the highest increase of 490 kg/ha (247.47%) was obtained in the treatment spraying of 1500ppm neem/azadirachtin at 7 DAS followed by seed treatment with chlorpyrifos (437 kg/ha, 220.71%), spraying of NSKE 5% at 7 DAS(428kg/ha, 216.16%), spraying of 1500ppm neem/azadirachtin at 15 DAS (417kg/ha, 210.6%), spraying of NSKE 5% at 15 DAS (412kg/ha, 308.08%), foliar application of neem oil 3% at 15

DAS (361kg/ha, 182.3%), 1.5 times of recommended seed rate (359kg/ha, 181%) and early sowing i.e. 15 days before the normal sowing (315kg/ha, 159%).

The total cost of application of different treatments varied from Rs/ha 386 to Rs/ha 3950 whereas the value of increased yield over control ranges from Rs 7180kg/ha to Rs 9800kg/ha. The economics highest value of increased yield/ha was obtained in spraying of 1500ppm neem/azadirachtin at 7 DAS (9800kg/ha) followed by seed treatment with chlorpyrifos (8740kg/ha), spraying of NSKE 5% at 7 DAS (8560kg/ha), spraying of 1500ppm neem/azadirachtin at 15 DAS (8340kg/ha), spraying of NSKE 5% at 15 DAS (8240kg/ha), foliar application of neem oil 3% at 15 DAS (7220kg/ha), 1.5 times of recommended seed rate (7180kg/ha) and early sowing i.e. 15 days before the normal sowing (6300kg/ha) that the highest net profit of Rs 9057 per hectare was achieved through the spraying of 1500ppm neem/azadirachtin at 7 DAS followed by seed treatment with chlorpyrifos (Rs 8354/ha) but the benefit per rupee investment was highest (1:21:64) in the treatment seed treatment with chlorpyrifos 20 EC @ 2.5ml/kg of seed because of low in put cost. This was followed by treatment of spraying of 1500ppm neem/azadirachtin at 7 DAS (1:12:18), Early sowing i.e. 15 days before the normal sowing (1:10:88), 1.5 times of recommended seed rate (1:10:39), Spraying of 1500ppm neem/azadirachtin at 15 DAS (1:10:22), Foliar application of neem oil 3% at 15 DAS (1:1.83), Spraying of NSKE 5% at 7 DAS (1:1.34) and Spraying of NSKE 5% at 15 DAS (1:1.25).

Table 6: Effectiveness and economics of various eco-friendly treatments comprising of cultural practices and botanicals on yield against Shootfly in little millet var. BG 1

TR. NO.	Treatment	Yield Kg/h	Increase in yield over control (kg/h)	Value of Increased yield over control (kg/ha)	Cost Treatment (Rs./h)	Profit (Rs./h)	Cost:Benefit
T ₁	1.5 times of recommended seed rate	557	359	7180	630	6550	1:10.39
T ₂	Early sowing i.e. 15 days before the normal sowing	513	315	6300	530	5770	1:10.88
T ₃	Spraying of 1500ppm neem/azadirachtin at 7 days after sowing	688	490	9800	743	9057	1:12.18
T ₄	Spraying of 1500ppm neem/azadirachtin at 15 days after sowing	615	417	8340	743	7597	1:10.22
T ₅	Foliar application of neem oil 3% at 15 DAE	559	361	7220	2550	4670	1:1.83
T ₆	Spraying of NSKE 5% at 7 days after sowing	626	428	8560	3650	4910	1:1.34
T ₇	Spraying of NSKE 5% at 15 days after sowing	610	412	8240	3650	4590	1:1.25
T ₈	Seed treatment with Chlorpyrifos 20 EC@ 2.5ml/kg of seed	635	437	8740	386	8354	1:21.64
T ₉	Control (Untreated)	198					
	SEm(±)	46.188					
	C.D. (5%)	139.663					
	C.V. (%)	14.396					

**Fig 1:** Effectiveness and economics of various eco-friendly treatments comprising of cultural practices and botanicals (neem based) against shootfly in little millet var. BG 1

Summary

In this experiment nine different treatments including control comprising of two cultural practices, three botanicals and two insecticides were tested for their efficacy against shootfly on varieties viz. BG1.

Spraying of 1500ppm neem/azadirachtin at 7 DAS found to be superior in reducing egg deposition as well as in reduction of deadheart per cent followed by seed treatment with chlorpyrifos 20 EC. These two treatments were followed in order of merit by chlorpyrifos 20 EC, Spraying of 1500ppm neem/azadirachtin at 15 DAS, foliar application of neem oil 3% at 15 DAS and Spraying of NSKE 5% at 7 DAS. Highest egg per 10 plants egg deposited was noticed in control (untreated).

Significantly highest yield was obtained in the application spraying of 1500ppm neem/azadirachtin at 7 DAS which was at par with chlorpyrifos 20 EC followed by NSKE 5% at 7 DAS, spraying of 1500ppm neem/azadirachtin at 15 DAS and NSKE 5% at 15 DAS neem oil. The lowest yield was obtained in untreated control.

The economics of various treatments indicates that the highest net profit was achieved through application spraying of 1500ppm neem/azadirachtin at 7 DAS (9057 Rs./ha) followed by the seed treatment with chlorpyrifos 20 EC at 2.5 ml/ kg of seed (8174 Rs/ha) but chlorpyrifos 20 EC gives maximum (1:21.64) profit per rupee investment (i.e. Cost benefit ratio) benefit followed by spraying of 1500ppm neem azadirachtin at 7 DAS (1:12:18) in BG 1.

Earlier, Mote and Jadhav (1993)^[7] reported that the extract of *Azadiracta indica*, *Argemone mexicana* and *Calotropis gigantean* were effective in reducing the level of shootfly in sorghum. Spraying of neem leaf extract at 7 DAE was recorded 39.7 per cent dead hearts was on par with carbofuran 3G whorl application (35.0%) (Anonymous 2001)^[2]. Neem seed kernel extract (50%) spray at 40 SAE with seed treatment with cruiser (3g/kg seed) and timely sowing recorded least per cent dead hearts (42.98%) and was comparable with farmer practice *i.e.*, timely sowing (80.23%) (Anonymous, 2004)^[3].

Conclusion

Spraying of 1500 ppm neem /azadiractin application should be applied at seventh day after sowing which gave maximum grain yield and minimum incidence of shootfly. However, highest cost benefit ratio was obtained with seed treatment with chlorpyrifos 20 EC @ 2.5 ml/kg of seed.

Further thrust under present investigation use of 1500ppm neem/azadiractin and seed treatment with chlorpyrifos 20 EC @ 2.5 ml/kg of seed in the form of spray application should in term of less shootfly infestation also in achieving higher yield. Apart from eco-friendly in nature, its application cost is very meagre. Therefore, even poor farmer can use this botanical to save his crop. So this treatment could further be tried against this dreaded pest to confirm its efficacy.

References

1. Anonymous. Annual progress report All India coordinated Research Project on /small millets. Rajendra Agricultural University, Bihar Trihut college of Agriculture, Dholi. In Cooperation with ICAR. 1991.
2. Anonymous. All India Co-ordinated Sorghum Improvement Project, NRC on Sorghum, Hyderabad. Ann. Rep. (2001-02), 2001, 24.
3. Anonymous. All India Co-ordinated Sorghum Improvement Project, NRC on Sorghum, Hyderabad. Ann. Rep. (2004-05), 2004, 22.
4. Borad PK, Mittal VP. Assessment of losses caused by pest complex of sorghum hybrid CSH-5. In: Crop losses due to Insect pests. Eds. Krishnamurthy, Rao, B.H. and Murthy, K.S.R.K., Entomologica Society of India, Rajendranagar, Hyderabad, 1983, 271-278.
5. Jotwani MG, Sukhani TR. Seed treatment of sorghum in the control of shootfly, *Atherigona varia soccata* Rond. Pesticides, 1968; 22:40-41
6. Katole SR, Nimbalkar SA, Kolhe AV, Ghuguskar HT, Yadgirwar PV. Performance of some IPM modules against *Helicoverpa armigera* Hub. on chickpea. Punjabrao Krishi Vidyapeet Research Journal. 2000; 24(1):51-53.
7. Mote UN, Jadhav SS. Effect of indigenous plant products on shoot fly damage in sorghum. Journal of Maharashtra Agricultural Universities. 1993; 18(1):135.
8. Singh SP, Batra GR. Effect of neem formulations on shoot fly, *Atherigona soccata* (Rondani) oviposition and infestation in forage sorghum. Journal of Research, 2001; 9.
9. Vedamoorthy G, Thobbir VV, Matai BH, Young WR. Preliminary studies with seed and seed furrow application of insecticides for the control of the sorghum stem maggot *Atherigona indica* Malloch (Anthomyiidae). Indian J Agric. Sci. 1965; 35(1):14-28.