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KG Shete
P.G. Scholar Department of Entomology, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

BV Patil
Associate Professor (Entomology), Department of Entomology, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

NR Pawara
P.G. Scholar Department of Entomology, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Correspondence
KG Shete
P.G. Scholar Department of Entomology, College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Evaluation of different seed treatments for the management of soybean pests

KG Shete, BV Patil and NR Pawara

Abstract
An investigation on "Evaluation of different seed treatments for the management of soybean pests" the field experiment was conducted at research farm, Department of Agricultural Entomology, College of Agriculture, Badnapur. During *Kharif* season 2017. The experiment was conducted under the Randomized Block Design (RBD) with eight treatments and three replications.
The treatments comprised of imidacloprid 48 FS @1.25ml/kg seed, thiamethoxam 30 FS @ 5ml/mrl, thiamethoxam 30FS @10ml/kg seed, phorate 10 G @ 15 kg/ha, chlorpyriphos 20 EC @ 4ml/kg seed, carbosulfan 25 FS @ 30ml/kg seed, triazophos 40 EC @12.5ml/10lit (spray) and untreated control.
The experimental result indicates that the seed treatment with imidacloprid 48FS@1.25ml/kg seed was effective against the leaf miner, stem fly, girdle beetle, *S. litura* and *C. acuta* upto 30 DAG. After the spraying of triazophos 40EC @ 12.5 ml/10 lit at 30 DAG and 45 DAG it was found most effective in reducing mainly the leaf miner infestation, *S. litura* and *C. acuta* population.
The highest seed yield (2517kg/ha) was recorded in plot treated with imidacloprid 48FS@1.25 ml/kg seed followed by thiamethoxam 30 FS @ 5ml/kg seed (2344kg/ha).
An experimental result regarding Cost Benefit Ratio shows that highest ICBR was obtained in imidacloprid 48FS @ 1.25ml/kg seed (1:1.81) followed by thiamethoxam 30 FS @ 5ml/kg seed (1:1.62).

Keywords: Seed treatments, stem fly, girdle beetle, *Spodoptera litura*, *Chrysodeixis acuta*, yield, ICBR

Introduction
Soybean is a wonder crop of twentieth century. It is an excellent source of protein and oil. It is two dimensional crop as it contains about 40 per cent high quality protein and 20-22 per cent oil besides minerals and vitamins. It ranks first among the oilseeds in the world as well as in India. In India it grown on 101.56 Lakh ha with the production of 83.50 Lakh metric tons and an average yield of 822 kg per ha. Soybean accounts more than 34.48 lakh ha area with production of 29.0 lakh metric tons in Maharashtra (SOPA 2017) [1]. In Marathwada region of Maharashtra, about 16 different species of insect pests have been reported on soybean. The important ones are leaf miner (*Aproaerema modicella*, Deventer), stem fly (*Melanagromyza sojae*, Zehntner), girdle beetle (*Obereopsis brevis*, Gahan), leaf eating caterpillar (*Spodoptera litura*, Fabricius) and green semilooper (*Chrysodeixis acuta*). These insect are causing appreciable loss to the crop the reforeto grow the resistant varieties is the better option which can help to minimize the cost of pest management. Plant protection during the early stage of crop is very much essential to avoid losses. To avoid the losses caused by insect pests, various control measures have been designed. These include cultural, mechanical, biological and chemical methods. Out of various methods of pest control, control with chemical insecticide is best, which gives quick results. However, more importance was given to chemical control measures to control specific insect pest. Pesticides form an essential part of crop protection technology that make it possible for the farmers to feed the ever growing population. It has become necessary to manage the pests effectively. It was seen that the maximum seedling mortality occurs till 30 days after germination. The seed treatment seems to be best option to protect the crop till 40 days after germination hence the present study of evaluation of different seed treatments against stem fly, girdle beetle and defoliators was taken up during *Kharif* 2017.

Material and Methods
The experiment was laid out in randomized block design (RBD) with eight treatments including untreated control replicated three times.

This crop was sown on 11th July 2017 in plot size of 15 square meters with spacing 45×5cm. The crop management practices (i.e. field preparation, sowing, weeding, fertilizer application, etc.) were adopted as per the recommended practices.

Table 1: Details of insecticidal treatments

TTr. No.	Treatments	Dose
T1	Imidacloprid 48FS (ST)	1.25 ml/Kg seed
2	Thiamethoxam 30FS (ST)	5.0 ml/Kg seed
3	Thiamethoxam 30FS (ST)	10.0 ml/Kg seed
4	Chlorpyriphos 20EC (ST)	4 ml/Kg seed
5	Phorate 10G (SA)	15 Kg/ha
6	Carbosulfan 25FS (ST)	30 ml/Kg seed
7	Triazophos 40EC (spray)	12.5 ml/10 lit water
8	Untreated check	--

1. Stem fly

Observations on seedling mortality was recorded at 15 and 30 days after germination and observation on per cent infestation was recorded by uprooting the randomly selected 10 plants from each plot and dissected to observe the stem fly infestation and percentage stem fly damage was worked out.

2. Girdle beetle

Number of girdled plants by girdle beetle were counted and tagged in each plot by recording the number of plants showing ring formation and typical cutoff symptoms at 7, 14, 21, 28, 35, 42 days after germination and expessed as percent damage.

3. Leaf miner

Observation on number of infested leaflets with live larvae and total number of leaflets was recorded from five randomly selected plants in each plot and worked out in per cent damage. The observations will be recorded at 7, 14, 21, 28, 35, 42 days after germination**.**

4. Leaf eating caterpillar, Green semilooper

Observation on larval population of leaf eating caterpillar, green semilooper was taken at three spots of one meter row length. Larval counts were made by shaking the plant gently over a white cloth placed between the rows of average number of caterpillars per meter row length (mrl) was worked out at 15, 30, 45 and 60 days after germination.

Yield and quality parameters

At harvest the pods from each plots was taken separately leaving border rows and the yield data was computed to Kg/ha.

Incremental Cost Benefit Ratio (ICBR)

Grain yield of soybean from each treatment was recorded and additional income obtained from management practices over untreated check was worked out.

Statistical analysis

The data on lepidopteran pests were subjected to $\sqrt{(x + 0.5)}$ transformation before analysis. The percent damage by borers and leaf miner was subjected to angular transformation. The data was statistically analyzed by standard analysis of variance methods suggested by Panse and Sukhatme (1967) [6]. The variance due to treatment were compared against variance due to error to test the null hypotheses by ‘F’ test of significance at p= 0.05.

Results and Discussion

Leaf miner

There was no infestation noticed in all treatments including control which indicates that the pest was inactive till 7th day after germination. On 14th day after germination there were significant differences among the treatments compare to control. The infestation of leaf miner was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (1.1%) which is significantly superior over control and at par with thiamethoxam 30 FS @ 5ml/kg seed (1.8%). The infestation of leaf miner was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (3.5%) which is significantly superior over control and at par with thiamethoxam 30 FS @ 5ml/kg seed (4.3%) followed by chlorpyriphos 20 EC @ 4ml/kg seed (4.7%) and Phorate 10G @15 kg/ha (5.3%) on 21th DAG. Compare to control the infestation of leaf miner was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (5.0%) which is significantly superior over control and at par with thiamethoxam 30 FS @ 5ml/kg seed (5.7%) followed by chlorpyriphos 20 EC @ 4ml/kg seed (6.2%), Phorate 10G @15kg/ha (6.6%) and thiamethoxam 30 FS @ 10ml/kg seed (7.2%) on 28th DAG. On 35th DAG the infestation of leaf miner was recorded significantly lowest in triazophos 40EC @12.5ml/10lit (4.5%) which was significantly superior over control as spraying is done on 30th DAG. On 42ththe infestation of leaf miner was recorded significantly lowest in triazophos 40EC @12.5ml/10lit (5.4%) which was significantly superior over control.

Table 2: Effect of different seed treatments on *A. modicella* infestation

Sr. No.	Treatments	% Infestation					
		7 DAG	14 DAG	21 DAG	28 DAG	35 DAG	42 DAG
T1	Imidacloprid @ 48 FS 1.25 ml/kg seed	0.0(0.00)	1.1(6.05)	3.5(10.81)	5.0(12.84)	8.3(16.70)	9.1(17.54)
T2	Thiamethoxam 30 FS @ 5 ml/kg seed	0.0 (0.00)	1.8 (7.66)	4.3 (11.87)	5.7 (13.73)	8.8 (17.16)	9.3 (17.61)
T3	Thiamethoxam 30 FS @10 ml/kg seed	0.0(0.00)	3.9(11.45)	6.1(14.29)	7.2(15.50)	9.3(17.63)	10.1 (18.52)
T4	Phorate 10G@ 15 kg/ha	0.0(0.00)	3.2(10.33)	5.3(13.32)	6.6(14.87)	10.0(18.39)	11.5(19.73)
T5	Chlorpyriphos 20 EC @4 ml/kg seed	0.0(0.00)	2.3(8.61)	4.7(12.50)	6.2(14.42)	9.6(18.00)	12.6(20.73)
T6	Carbosulfan 25 FS @30 ml/kg seed	0.0(0.00)	3.8(11.19)	6.2(14.36)	7.4(15.75)	10.5(18.88)	10.4(18.77)
T7	Triazophos 40 EC Spray @12.5 ml/10 lit. water	0.0(0.00)	5.1(13.05)	8.7(17.07)	10.5(18.88)	4.5(12.18)	5.4(13.35)
T8	Untreated check	0.0(0.00)	5.3(13.34)	9.3(17.71)	11.1(19.40)	13.7(21.74)	13.1(21.13)
	S.E(m)±		0.73	0.98	0.91	1.10	1.13
	C.D. 5%		2.15	2.88	2.68	3.22	3.32
	C.V.		12.44	12.17	10.10	10.84	10.66

*Figures in parentheses are arc sine transformed values

Seedling mortality due to stem fly

On 15th DAG the lowest seedling mortality was noticedin imidacloprid 48 FS @ 1.25ml/kg seed (0.18%) which is significantly superior over control and at par with thiamethoxam 30 FS @ 5ml/kg seed (0.23%) followed by thiamethoxam 30 FS @ 10ml/kg seed (0.35%). The seedling mortality was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (0.62%) which was significantly superior over control and at par with thiamethoxam 30 FS @ 5ml/kg seed (0.81%).

Per cent infestation due to stem fly

At flowering the lowest infestation were noticedin imidacloprid 48 FS @ 1.25ml/kg and triazophos 40EC @12.5ml/10lit (40.0%) which is significantly superior over control and at par with thiamethoxam 30 FS @5ml/kg seed (50.0%), thiamethoxam 30 FS @ 10ml/kg seed (53.3%) and chlorpyriphos 20 EC @4ml/kg seed (53.3). The infestation was recorded significantly lowest in triazophos 40EC @12.5ml/10lit (56.7%) which was significantly superior over control and at par with imidacloprid 48 FS @ 1.25ml/kg (63.3%) followed by thiamethoxam 30 FS @ 5ml/kg seed (70.0%) at harvesting.

The results of present investigation are discussed in the light of findings of previous workers.

Patil and Kulkarni (2004) [8] reported that thiamethoxam 70WS as a seed dresser for soybean was highly effective in reducing the stem fly infestation (7.90%) as compared to soil application of carbofuran, phorate and untreated check.

Nage *et al*., (2013) [5] the seed treatment with imidacloprid 70WS @12 g per kg was highly significant in recording lowest stem fly infestation/per plant (5.26 per cent per meter row length).

Table 3: Effect of different seed treatments on seedling mortality by stem fly

S. No	Treatments	Seedling Mortality %		Stem fly % Infestation	
		15 DAG	30 DAG	AT Flowering	At Harvesting
T1	Imidacloprid 48FS@ 1.25 ml/kg seed	0.18(2.42)	0.62(4.50)	40.0(39.15)	63.3(52.78)
T2	Thiamethoxam 30FS@ 5 ml/kg seed	0.23(2.74)	0.81(5.10)	50.0(45.00)	70.0(57.0)
T3	Thiamethoxam 30FS @ 10ml/kg seed	0.35 (3.32)	1.32(6.59)	53.3(46.92)	80.0(63.93)
T4	Phorate 10G @15kg/ha	0.54 (4.16)	1.87(7.83)	56.7(48.85)	76.7(61.71)
T5	Chlorpyriphos 20EC @4 ml/kg seed	0.39 (3.57)	1.22 (6.26)	53.3 (47.01)	73.3 (59.00)
T6	Carbosulfan 25FS@ 30ml/kg seed	0.62(4.50)	2.10(8.31)	56.7(48.85)	80.0 (63.93)
T7	Triazophos 40EC @ 12.5ml/10lit. Water. (Spray)	2.10 (8.33)	3.82 (11.20)	40.0 (39.15)	56.7 (48.85)
T8	Untreated check	2.27 (8.64)	4.07 (11.64)	66.7 (54.78)	86.7 (68.86)
	SE(m)±	0.33	0.53	2.95	3.45
	C.D at 5%	0.98	1.55	8.67	10.13
	C.V.	12.34	11.96	11.09	10.05

*Figures in parentheses are arc sine transformed values.

Girdle beetle

The infestation was recorded significantly lowest inimidacloprid 48 FS @ 1.25ml/kg (10.76%) which was significantly superior over control and at par with triazophos 40EC @12.5ml/10lit (11.51%), thiamethoxam 30 FS @ 5ml/kg seed (12.11%) and phorate 10G@ 15 kg/ha (13.94%).

The results of present investigation are discussed in the light of findings of previous workers.

Salunke (1999) [9] observed lowest infestation of girdle beetle with carbofuran @30 kg/ha followed by phorate 10G @10kg/ha.

Patil and Kulkarni (2004) [8] reported that thiamethoxam 70WS as a seed dresser for soybean was highly effective in reducing the girdle beetle infestation (5.85%) as compared to soil application of carbofuran, phorate and untreated check.

Table 4: Effect of seed treatments on girdle beetle damage

S. No	Treatments	Per cent damage (%)
T1	Imidacloprid 48FS @1.25ml/kg seed	10.76 (19.12)
T2	Thiamethoxam 30FS @5ml/kg seed	12.11 (20.35)
T3	Thiamethoxam 30FS @10ml/kg seed	15.78 (23.24)
T4	Phorate 10G @15kg/ha	13.94 (21.90)
T5	Chlorpyriphos 20EC @4ml/kg seed	16.01 (23.52)
T6	Carbosulfan 25FS @30 ml/kg seed	18.19 (25.19)
T7	Triazophos 40EC Spray @12.5 ml/10lit.water	11.51 (19.82)
T8	Untreated check	26.12 (30.52)
	S.E(m)±	1.93
	C.D. 5%	4.02
	C.V.	10.34

*Figures in parentheses are arc sine transformed values.

Spodoptera litura

At 15 DAG the lowest population of *S. litura* (0.0 larvae/mrl) were recorded in imidacloprid 48 FS @ 1.25ml/kg seed and thiamethoxam 30 FS @ 5ml/kg seed which was significantly superior over control followed by phorate 10G @15kg/ha (0.1 larvae/mrl), chlorpyriphos 20 EC @ 4ml/kg seed (0.1 larvae/mrl), thiamethoxam 30 FS @ 10ml/kg seed (0.2 larvae/mrl), carbosulfan 20 FS @ 30ml/kg seed (0.2 larvae/mrl).The population of *S. litura* was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (0.9 larvae/mrl) followed by thiamethoxam 30 FS @ 5ml/kg seed (1.0 larvae/mrl), thiamethoxam 30 FS @ 10ml/kg seed (1.3 larvae/mrl) and chlorpyriphos 20 EC @ 4ml/kg seed (1.6 larvae/mrl) at 30 DAG. At 45 DAG the population of *S. litura* was recorded significantly lowest (2.3 larvae/mrl) in triazophos 40EC @12.5ml/10lit followed by imidacloprid 48

FS @ 1.25ml/kg seed (3.3 larvae/mrl), thiamethoxam 30 FS @ 5ml/kg seed (3.4 larvae/mrl). Maximum reduction of *S. litura* at 60 DAG was recorded in triazophos 40EC @12.5ml/10lit (2.1 larvae/mrl) which was significantly superior over control.

Patil *et al*., (2015) [7] reported that the insecticides imidacloprid 70WS @10 g/kg seed proved to be most effective treatment in reducing leaf eating caterpillar (1.27 larvae/plant) and carbosulfan 25SD @30g/kg seed (1.81 larvae/plant).

Table 5: Effect of different seed treatments on *S. litura* incidence

S. No	Treatments	Average larvae/mrl			
		15 DAG	**30 DAG**	**45 DAG**	**60 DAG**
T1	Imidacloprid 48FS@ 1.25 ml/kg seed	0.00(0.71)	0.9(1.17)	3.3(1.94)	4.7(2.26)
T2	Thiamethoxam 30FS @5 ml/kg seed	0.00(0.71)	1.0(1.22)	3.4(1.98)	4.8(2.30)
T3	Thiamethoxam 30FS @ 10ml/kg seed	0.2(0.84)	1.3(1.35)	4.2(2.17)	5.0(2.34)
T4	Phorate 10G @15kg/ha	0.1(0.78)	1.9(1.54)	4.6(2.25)	5.9(2.52)
T5	Chlorpyriphos 20EC @4 ml/kg seed	0.1(0.78)	1.6(1.41)	4.3(2.19)	5.2(2.39)
T6	Carbosulfan 25FS@ 30ml/kg seed	0.2(0.84)	1.8(1.51)	4.9(2.32)	5.8(2.50)
T7	Trizophos 40EC @12.5ml/10lit. water. Spray	0.4(0.97)	3.4(1.98)	2.3(1.67)	2.1(1.61)
T8	Untreated check	0.6(1.02)	3.4(1.98)	5.2(2.38)	6.1(2.54)
	SE (m)	0.053	0.09	0.12	0.13
	C.D.	0.15	0.29	0.36	0.39
	C.V.	11.24	11.35	10.31	10.10

*figures in parentheses are √x+0.5 transformed values

Chrysodeixis acuta

At 15 DAG the minimum population of *C. acuta* was noticed in imidacloprid 48 FS @ 1.25ml/kg seed (0.0 larvae/mrl) which was significantly superior over control followed by thiamethoxam 30 FS @ 5ml/kg seed (0.1 larvae/mrl), phorate 10G @15kg/ha (0.2 larvae/mrl), chlorpyriphos 20 EC @ 4ml/kg seed (0.2 larvae/mrl), thiamethoxam 30 FS @ 10ml/kg seed (0.2 larvae/mrl), carbosulfan 20 FS @ 30ml/kg seed (0.22 larvae/mrl). The population of *C. acuta* was recorded significantly lowest in imidacloprid 48 FS @ 1.25ml/kg seed (2.3 larvae/mrl) which was significantly superior over control followed by thiamethoxam 30 FS @ 5ml/kg seed (2.4 larvae/mrl), thiamethoxam 30 FS @ 10ml/kg seed (2.6 larvae/mrl), chlorpyriphos 20EC@ 4ml/kg seed (2.7 larvae/mrl), phorate 10G @15kg/ha (3.0 larvae/mrl), carbosulfan 20 FS @ 30ml/kg seed (3.2 larvae/mrl) at 30 DAG. The population of *C. acuta* was recorded significantly lowest in triazophos 40EC @12.5ml/10lit (3.1 larvae/mrl) which was significantly superior over control followed by imidacloprid 48 FS @ 1.25ml/kg seed (4.7 larvae/mrl) at 45 DAG. Maximum reduction of *C. acuta* at 60 DAG was recorded in triazophos 40EC @12.5ml/10lit (2.9 larvae/mrl) which was significantly superior over control.

The results of present investigation are discussed in the light of findings of previous workers.

Choudhary *et al*., (2007) [2] Triazophos at 825 and 1000 ml/ha resulted in the lowest larval population (0.24 larvae/mrl).

Table 6: Effect of different seed treatments on *Chrysodeixis acuta*

S. No	Treatments	Average larvae/mrl			
		15 DAG	**30 DAG**	**45 DAG**	**60 DAG**
T1	Imidacloprid 48FS @1.25 ml/kg seed	0.0(0.71)	2.3(1.68)	4.7(2.27)	5.1(2.31)
T2	Thiamethoxam 30FS @5 ml/kg seed	0.1(0.78)	2.4(1.71)	5.1(2.36)	5.3(2.41)
T3	Thiamethoxam 30FS @10 ml/kg seed	0.2(0.84)	2.6(1.74)	5.2(2.39)	5.6(2.46)
T4	Phorate 10G @15 kg/ha	0.2(0.84)	3.0(1.86)	5.7(2.48)	6.3(2.61)
T5	Chlorpyriphos 20EC @4 ml/kg seed	0.2(0.84)	2.7(1.77)	5.4(2.43)	5.9(2.53)
T6	Carbosulfan 25FS @30 ml/kg seed	0.22(0.84)	3.2(1.92)	5.8(2.50)	6.4(2.63)
T7	Trizophos 40EC Spray @12.5 ml/10 lit.water	0.4(0.97)	4.3(2.20)	3.1(1.88)	2.9(1.84)
T8	Untreated check	0.6(1.02)	4.2(2.16)	6.4(2.61)	6.6(2.43)
	S.E(m)±	0.059	0.11	0.13	0.14
	C.D. 5%	0.17	0.32	0.40	0.41
	C.V.	12.08	10.22	10.03	10.20

*figures in parentheses are √x+0.5 transformed values

Yield

The maximum grain yield of 2517 kg/ha was obtained in seed treatment with imidacloprid 48FS @1.25 ml/kg which was at par with thiamethoxam 30FS @5 ml/kg seed (2344 kg/ha).

The results obtained in the present investigation are in accordance with the findings of previous workers.

Singh *et al.* (2000) [11] and (Debjani *et al.* 2008) [3] who reported that thiamethoxam 70WS @3g and 5g/kg seeds**,** thiamethoxam 70WS @1.5g/kg seed, thiamethoxam 500FS @1.5g/kg seed and imidacloprid 70WS @10g/kg seed were the most effective and increased the grain yield significantly.

Salunke *et al*., (2004) [10] reported that the highest yield (27.57 q/ha) was recorded in carbosulfan 25DS @30g/kg seed and thiamethoxam 70WS @3g a.i./kg seed (25.54 q/ha) treatment.

Table 7: Effect of different seed treatments on yield of soybean

S. No	Treatments	Yield kg/plot			Total	Mean, yield kg/plot	Yield kg/ha
		R-I	R-II	R-III			
T1	Imidacloprid 48FS @1.25 ml/kg seed	2.583	2.913	3.245	8.74	2.9	2517
T2	Thiamethoxam 30FS @5 ml/kgseed	3.245	2.687	2.248	8.18	2.7	2344
T3	Thiamethoxam 30FS @10 ml/kg seed	1.781	2.514	2.758	7.05	2.4	2083
T4	Phorate 10G @15kg/ha	1.966	2.456	1.752	6.17	2.1	1823
T5	Chlorpyriphos 20EC @4 ml/kg seed	2.457	2.645	2.393	7.50	2.5	2170
T6	Carbosulfan 25FS @30 ml/kg seed	2.047	2.231	1.792	6.07	2.0	1736
T7	Trizophos 40EC Spray @12.5 ml/10lit.water	2.854	2.687	2.248	7.79	2.6	2257
T8	Untreated check	1.236	1.282	2.264	4.78	1.6	1389
	SE(m)					0.072	62.5
	C.D. at 5%					0.21	182
	C.V.					7.49	7.49

Incremental cost benefit ratio [ICBR]

The data on incremental cost benefit ratio revealed that the highest cost benefit ratio (1:1.81) was obtained in imidacloprid 48FS @1.25 ml/kg seed followed by thiamethoxam 30FS @5ml/kg seed (1:1.68), trizophos 40 EC Spray @12.5 ml/10 lit.water (1:1.6), chlorpyriphos 20 EC @/kg seed (1:1.5), thiamethoxam 30FS @10 ml/kg seed (1:1.49).

The results obtained in the present investigation are in accordance with the findings of previous workers.

Laxmigudi *et al*., (2014) [4] reported that, among the various seed treatments, net returns were highest in seed treatment with imidacloprid 60FS @5ml/kg seed with B:C ratio of 2.19 as compare to thiamethoxam 35FS @5ml/kg seeds and 10 ml/kg seed with less B: C ratio 1.81 and 1.99.

Singh and Singh (1989) [12] tested phorate and carbofuran at different condition and timing in soybean and obtained maximum grain yield and cost benefit ratio (1: 2.28) from the treatment 10 kg/ha, 25 days after germination.

Table 8: Incremental Cost Benefit Ratio [ICBR] of different insecticidal treatments

Tr. No.	Treatments	Yield (Kg/ha)	MC (Rs)	MP (Kg/ha)	MR (Rs)	NR (Rs)	CBR (Rs)
T1	Imidacloprid 48FS @1.25 ml/kg seed	2517	420	1128	88095	87675	1:1.81
T2	Thiamethoxam 30FS @5 ml/kg seed	2344	1250	955	82040	80790	1:1.68
T3	Thiamethoxam 30FS @10 ml/kg seed	2083	2000	694	72905	70905	1:1.49
T4	Phorate 10G@ 15kg/ha	1823	1450	434	63805	62355	1:1:1.3
T5	Chlorpyriphos 20EC @4 ml/kg seed	2170	376	781	75950	75574	1:1:1.5
T6	Carbosulfan 25FS @30 ml/kg seed	1736	4120	347	60760	56640	1:1.24
T7	Trizophos 40EC Spray @12.5 ml/10lit.water	2257	751	868	78995	78244	1:1.6
T8	Untreated check	1389		-	48615	-	-

MC- Marginal cost [Cost of insecticides + 1 labour Rs. 250 per day]
MP- Marginal product (Increase in yield over control)
MR- Marginal returns (Gross Income)
NR- Net returns (Net income)
ICBR- Incremental Cost Benefit Ratio
Market return of Soybean per quintal is 3500

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