Indian Journal of Entomology 85(3): 692-696 (2023) DoI. No.: 10.55446/IJE.2022.669

MANAGEMENT OF RODENT PESTS IN WHEAT SOWN UNDER DIFFERENT TILLAGE SYSTEMS

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ABSTRACT

Investigation to manage rodent pests in wheat crop sown with different tillage methods was conducted. The results revealed maximum efficacy in the form of control success (%) on plain bait consumption and burrow count basis with conventional (92.30) followed by zero tillage (84.74) and maize residue tillage (74.38). In these, rodenticide treatments with double burrow baiting was followed by single paper baiting. Lesser % cut tillers (0.39-0.53) and damage 9.56-15.71 kg/ 0.4 ha were observed in these. Burrow count in maize residue and zero tillage was 2.15 and 1.60x more than conventional tillage. Thus, rodenticide treatments with double burrow baiting at vegetative stage in December (bromadialone followed by zinc phosphide at 15 days interval) along with paper baiting (bromadialone) at reproductive stage (end February to 1st week of March) can be recommended against rodents in wheat crop to get higher economic returns (Rs.452.36-556.81/ 0.4 ha).

Key words: Bromadialone, burrow baiting, cut tillers, maize residue, paper bait, rodents, rodenticide, tillage, wheat crop, zinc phosphide

Wheat is a major cereal crop and in Punjab, it is grown on an area of 35.20 lakh hectares with production of 176.20 lakh mt (Anonymous, 2021). Crop residues are important natural resources and their conservation has many advantages (Singh et al., 2000; Khaliq et al., 2013, 2015), and it can induce sustainability (Collins et al., 1992; Hussain et al., 2015). Incorporation of residues in soil and surface mulching are important tactics (Jensen, 1997; Sidhu and Beri, 2005). When wheat crop is sown with happy seeder machine having maize residues as mulch in field, it inhabits more rodents than conventional methods. Tillage is one of the major crop production operations and is an important contributor to the cost of production (Uri,1999). It is estimated that tillage and sowing almost consumes 25% of the total operational energy in wheat production (Singh et al., 2008). Zero tillage and happy seeder methods are environment friendly and reduce cost of cultivation (Filipovic et al., 2006). There is an urgent need to reduce the cost of cultivation and increase the productivity with adoption of conservation tillage practices (Sharma et al., 2002). Happy seeder technology which involves low production cost is an important tool for residue management, but this practice provides congenial environment for rodent survival and their multiplication. Along with straw management, there is need to manage rodent population in wheat crop sown with different tillage systems. This study is designed to determine the time and method of rodenticide bait application required to keep the rodent population under check in wheat crop sown with maize residue, zero and conventional tillage methods under Punjab conditions.

MATERIALS AND METHODS

The experiment was conducted at the village Ladhowal District, Ludhiana, Punjab (30.91°N,75.85°E). Wheat crop is sown here in November-December and harvested during April. Wheat crop was sown in different tillage systems (i) fields having maize residues as mulching material left in the field and crop was sown with happy seeder machine directly (ii) zero tillage where crop was sown directly with drill machine without any tillage (iii) conventional tillage where 3-4 tillage operations (tillers and suhaga) were practiced. To carry out experiments, two rodenticides were used, bromadialone (0.005%) which is a chronic and anti-coagulant poison and other zinc phosphide (2%) which is an acute poison. Both rodenticides were purchased from local market under trade names Ruban^R and Rantil^R, respectively. For the preparation of one kg poison bait, properly mixed cracked wheat grains (935 g), powdered sugar (20 g) and vegetable oil (20 g) and zinc phosphide (25 g) was added to this mixture. On this similar pattern, bromadialone based poison bait was prepared where the weight of bromadialone was taken as 20 g and of wheat grains as 940 g, with other ingredients remaining same (Anonymous, 2015a).

For burrow baiting, all the burrows were closed with soil by spade or khurpa, a day before treatment in the evening and all the reopened burrows next day (called live burrow) were treated with rodenticide bait. About 10 g of rodenticide bait was taken in a loose paper boat and placed about 15 cm deep inside each live burrow with a stick and again covered with soil. Similarly, for paper baiting, 10 g of rodenticide bait (@400g/ 0.4 ha) was placed on a piece of paper at 40 bait points in a 10x 10m grid in fields and near bunds of 0.4 ha each. To observe effect of rodenticides, two methods were used: pre- and post-census on plain bait consumption basis (without rodenticide) recorded before and after each treatment to calculate % control success (on plain bait consumption basis); and burrow count (burrow census) in which all the burrows were counted with naked eyes to record population and predominance of rodent species and to calculate % control success (on burrow count basis). Rodent damage (% cut tillers) was assessed at preharvest stage by taking five samples of 1 m^2/ 0.4 ha in two diagonal lines to cover center as well as all the four geographical sides. In each sample, the number of healthy tillers and tillers cut by rodents were counted. Yield loss (kg/ 0.4 ha) was calculated following Singla and Babbar (2010). There were five blocks selected, each of 0.4 ha, with three replications. In block I, double burrow baiting treatment during vegetative stage, 1st with bromadialone and 2nd with zinc phosphide (15 days after 1st treatment) along with single paper baiting with bromadialone at reproductive stage were practiced. In block II, single burrow baiting treatment with bromadialone along with single paper baiting with bromadialone were practiced. In block III only single paper baiting with bromadialone and in block IV single burrow baiting with bromadialone were practiced, whereas block V was kept as control, where no treatment was done. Burrow baiting was done during vegetative stage of wheat crop (7 days after sowing during December) and paper baiting during reproductive stage of wheat crop (end February to 1st week of March). In all selected blocks, farmer had grown recommended PBW-343 wheat variety and also adopted agronomic practices (irrigation, fertilizers, weed and insect control etc.) as recommended in "Packages of practices for rabi crops of Punjab" by Punjab Agricultural University, Ludhiana (Anonymous, 2015b). Data was calculated as mean± standered error and further two-way ANOVA and Tukey's HSD tests were performed to test level of significance.

RESULTS AND DISCUSSION

The results revealed that all the treatments show significant results, and after 1st treatment of burrow baiting with bromadialone the % control success (on burrow count basis) ranged from 51.30-61.16; in block I where 2nd burrow baiting was practiced with zinc phosphide at 15 days interval, higher control success was observed (76.93-82.07%) (Table 1). After 3rd treatment of bromadialone as paper baiting during reproductive stage in the end of February, maximum control success was in blocks having wheat sown with conventional tillage method followed by zero tillage and maize residue tillage; with maximum in block I (74.38-92.30%). Interestingly, similar results were observed when % control success was calculated on plain bait consumption basis; maximum control success was recorded in block I with conventional tillage (82.81) followed by zero tillage (78.73) and maize residue tillage (73.71); in block II, maximum ontrol success (71.26%) was recorded in conventional tillage, and in block III and IV where only single burrow baiting and single paper baiting were practiced, respectively, control success was less. Maximum rebuildup of rodent population was observed in controls and block III and IV. Conrol success (%) in all the treated blocks were non-significantly different with $p=0.12$ (at two way ANOVA) when compared among maize residue tillage, zero tillage and conventional tillage. Among all the treated blocks, block I was significantly different ($p=0.00$ and Tukey's HSD test).

No, significant difference was found in fields where single burrow/ paper baiting treatments were practiced. Interestingly, lower % cut tillers were recorded in treated block I (0.39-0.53) being lowest in conventional tillage. Similar pattern was observed as regards yield loss, with lesser loss being in block I and higher in block I. These parameters were lowest in conventional tillage. Wheat crop sown with happy seeder on maize residue has lower cost of cultivation and increases soil health. But it slightly encourages rodents due to leaves and cobs lying on the fields. In zero tillage, there is again least disturbance of soil which leads to higher rodent burrow count, as compared to conventional one. In all tillage methods, there was predominance of Indian gerbil *Tatera indica*, field mouse *Mus booduga* and lesser bandicoot rat *Bandicota bengalensis* (Table 2). In fields with maize residue and zero tillage, the number of burrows was 2.15 and 1.60x more than conventional tillage, respectively, and more so with maize residue tillage fields. Number of burrows in all the treated blocks were significantly different ($p=0.00$) when individually compared among maize residue, zero and conventional tillage. Also, there

Table 1. Efficacy off rodenticide treatments in wheat crop sown with different tillage methods

Block	Maize residue tillage				Zero tillage				Conventional tillage			
	% Control success (on burrow count basis)			% Control success (on plain bait consumption basis)	% Control success (on burrow count basis)			% Control success (on plain bait consumption basis)	% Control success (on burrow count basis)			% Control success (on plain bait consumption basis)
	After 1st treatment (BB)	After 2nd treatment (BB)	After 3rd treatment (PB)	After 3rd treatment (PB)	After 1st treatment (BB)	After 2nd treatment (BB)	After 3rd treatment (PB)	After 3rd treatment (PB)	After 1st treatment (BB)	After 2nd treatment (BB)	After 3rd treatment (PB)	After 3rd treatment (PB)
Block I	54.88± 2.51	76.93± 2.87	^{a}74.38± 3.57	^{a}73.71± 2.96	57.2± 2.01	77.97± 2.87	^{a}84.74± 2.39	^{a}78.73± 3.14	51.30± 1.01	82.07± 0.95	^{a}92.30± 3.25	^{a}82.81± 3.07
Block I	58.76± 2.38	41.28± 3.45	^{b}67.64± 4.09	^{b}63.04± 5.24	60.63± 1.84	51.54± 1.98	^{b}72.72± 4.50	^{b}66.02± 4.15	55.55± 0.75	40.77± 1.08	^{b}88.88± 3.18	^{b}71.26± 5.10
Block III	--	--	^{b}60.55± 4.84	^{b}56.63± 1.38	-	-	^{b}62.50± 3.81	^{b}57.89± 4.15	--	--	^{b}68.75± 4.53	^{b}61.46± 5.38
Block IV	59.81± 4.43	43.36± 3.10	^{b}44.86± 5.32	^{c}46.89± 2.49	59.39± 1.96	51.57± 3.54	^{c}48.42± 3.57	^{c}43.31± 2.65	61.16± 1.10	48.33± 3.76	^{c}47.25± 1.24	^{c}51.11± 3.20
Block V (Control)	--	--	--	--	-	-	--	--	--	--	--	--

BB=Burrow baiting; PB= Paper baiting; values mean± S.E.; a, b, c, shows significant difference between values along the column

Table 2. Burrow count, yield loss and cut tillers (%) during pre-harvest stage with rodenticide treatments in wheat crop sown with different tillage methods

Block	*Bandicota bengalensis*	*Muss booduga*	*Tatera indica*	Total	Yield loss (kg/ 0.4 hectare)	Cut tillers (%)
Maize residue tillage						
Block I	0.33± 0.02	3.33± 0.98	2.33± 0.27	[a]6.0± 1.24	[a]15.71± 1.25	[a]0.53± 0.07
Block II	4.0± 0.34	0± 0	3.0± 0.47	[a]7.0± 0.40	[a]21.3± 3.81	[a]1.22± 0.013
Block III	2.66± 0.44	4.0± 1.70	4.66± 0.27	[b]11.33± 2.68	[a]23.05± 4.71	[b]1.48± 0.12
Block IV	4.66± 0.72	3.0± 1.25	7.0± 2.05	[b]13.66± 3.92	[b]33.21± 3.06	[b]2.03± 0.50
Block V (Control)	5.66± 1.23	9.33± 1.44	8.66± 0.72	[c]23.66± 3.93	[c]46.13± 2.94	[c]4.65± 0.28
Zero tillage						
Block I	0.66± 0.27	0.66± 0.54	1.66± 0.27	[a]3.0± 0.47	[a]11.03± 1.73	[a]0.44± 0.13
Block II	1.0± 0.10	2.0± 0.14	0± 0	[a]3.0± 0.17	[a]16.10± 2.16	[a]0.74± 0.07
Block III	2.66± 0.98	1.66± 0.27	1.66± 0.72	[b]6.0± 1.25	[a]19.11± 3.14	[a]0.86± 0.08
Block IV	3.66± 0.54	2.0± 0.94	5.33± 0.98	[b]11.0± 1.24	[b]26.12± 2.76	[b]1.62± 0.12
Block V (Control)	4.0± 1.41	6.0± 1.89	7.33± 2.23	[c]17.33± 3.92	[c]37.6± 2.91	[c]2.85± 0.16
Conventional tillage						
Block I	0.0± 0.0	0.33± 0.27	0.66± 0.54	[a]1.0± 0.47	[a]9.56± 2.75	[a]0.39± 0.06
Block II	0± 0	1.0± 0.16	0± 0	[a]1.0± 0.16	[a]11.68± 3.48	[a]0.62± 0.11
Block III	1.33± 0.72	0.33± 0.27	3.33± 0.72	[b]5.0± 0.82	[a]18.41± 5.09	[a]0.75± 0.07
Block IV	1.33± 0.27	0.0± 0.0	3.66± 1.19	[b]5.0± 1.25	[b]24.11± 3.12	[b]1.58± 0.28
Block V (Control)	3.33± 1.09	1.33± 0.20	6.33± 0.72	[c]11.00± 1.63	[c]34.12± 4.02	[c]2.55± 0.46

Values mean± S.E.; a, b, c, shows significant difference between values along the column

was significant difference in burrow number between all treated blocks belonging to three tillage methods. Yield loss saved among treated blocks ranged from 10.01-30.42 kg/ 0.4 ha, being maximum in block I (Table 3). So, by adopting rodenticide treatment as suggested in block I, higher net benefit of Rs. 452.36-556.81/0.4 ha can be accomplished (Table 3).

In a study by Kocher and Kaur (2007) in sugarcane fields, double poison baiting with zinc phosphide and bromadialone @ 1600g poison bait/ ha at an interval of 15 days during end November gave significant reduction in grain loss. Singla and Babbar (2012) in sugarcane with three poison bait applications, first in July, second in October-November and third in January obtained good results. Bromadialone causes no bait shyness in rodents (Anonymous, 2015b). In a study, Singh et al. (2017) recorded higher control success in direct seeded basmati rice where burrow baiting was practiced with zinc phosphide at vegetative phase and paper baiting with bromadialone at reproductive phase. In potato, Kaur et al. (2018) obtained higher control success, lower cut tillers and yield loss, and post-harvest burrow count. Singla and Babbar (2010) observed about 4.84% rodent damage with yield loss of 196.0 kg/ ha among 29 villages from ten districts in Punjab. In conventional tillage 60-70% control success can be achieved when only single paper baiting practiced at reproductive phase. In zero tillage and maize residue tillage methods, there is least disturbance of soil which proliferate rodent population. Thus, it can be concluded that rodenticide treatments with double burrow baiting at vegetative stage during December (1st with bromadialone and after 15 days 2nd with zinc phosphide) along with paper baiting (bromadialone) at reproductive stage (end February to 1st week of March) are must to manage rodent pests in wheat crop sown with conventional tillage, zero tillage and maize residue tillage methods.

ACKNOWLEDGEMENTS

Authors thank the Head, Department of Zoology and Incharge, Vertebrate Pest management-Rodent section for providing facilities.

REFERENCES

Anonymous 2021. Wheat crop. Package of practices for crops of Punjab-Rabi, Punjab Agricultural University, Ludhiana. pp. 1-21.

Anonymous 2015a. Management of rodents and birds. Package of practices for crops of Punjab-Rabi, Punjab Agricultural University, Ludhiana. pp.110-113.

Anonymous 2015b. Wheat crop. Package of practices for crops of Punjab-Rabi, Punjab Agricultural University, Ludhiana. pp. 1-18.

Collins H P, Rasmussen P E, Douglas C L. 1992. Crop rotation and residue management effects on soil carbon and microbial dynamics. Soil Science Society of America Journal 56: 783-788.

Filipovic D, Silvio K, Zlatko G O, Robert Z, Djuro B. 2006. The possibility of fuel saving and reduction of CO_2 emission in the soil tillage in Croatia. Agriculture Ecosystem and Environment 115(1-4): 290-294.

Hussain S, Khaliq A, Matlob A, Fahad S, Tanveer A. 2015. Interference

Table 3. Economics of rodenticide treatments in wheat crop sown with different tillage methods

Block	Maize residue tillage				Zero tillage				Conventional tillage			
	Yield loss saved (kg/ 0.4 ha)	*Cost of saved wheat (Rs./ 0.4 ha)	Cost of rodenticide	**Net benefit (Rs./ 0.4 ha)	Yield loss saved (kg/ 0.4 ha)	*Cost of saved wheat (Rs./ 0.4 ha)	Cost of rodenticide	**Net benefit (Rs./ 0.4 ha)	Yield loss saved (kg/ 0.4 ha)	*Cost of saved wheat (Rs./ 0.4 ha)	Cost of rodenticide	**Net benefit (Rs./ 0.4 ha)
Block I	30.42	600.79	43.98	556.81	26.57	524.75	38.78	485.97	24.56	485.06	32.70	452.36
Block II	24.83	490.39	34.86	455. 53	21.50	424. 62	28.70	395.92	22.44	443.19	27.58	415. 61
Block III	23.08	455.83	22.54	433.29	18.49	365.17	22.54	342. 63	15.71	310.27	22.54	287.73
Block IV	12.92	255.17	20.16	235.01	11.48	226.73	12.32	214.41	10.01	197.69	10.08	187.61
Block V Control)		-	-		-	-	-	--	-	-	-	-

*Price of wheat crop (Rs. 1975/quintal) as per minimum support price by Government of India,2020-21; ** After deducting the cost of preparation of poison bait (zinc phosphide bait=Rs. 36.10/ kg and bromadiolone bait=Rs. 56.35/ kg)

and economic threshold level of little seed canary grass in wheat under different sowing times. Environmental Science and Research 22: 441-449.

Jensen E S. 1997. Nitrogen immobilization and mineralization during initial decomposition of N labeled pea and barley residues. Biology and Fertility of Soils 24: 39-44.

Kaur N, Singla N, Singh R. 2018. Efficacy of rodenticide bait application for rodent pest management in potato crop. Journal of Entomology and Zoology Studies 6(2): 2149-2152.

Khaliq A, Matloob A, Hussain A, Hussain S, Aslam F, Zamir S I, Chattha M U. 2015. Wheat residue management options affect crop productivity, weed growth and soil properties in direct seeded fine aromatic rice. Clean Soil Air and Water 43(8): 1259-1265.

Khaliq A, Gondal M R, Matloob A, Ullah E, Hussain S, Murtaza M. 2013. Chemical weed control in wheat under different rice residue management options. Pakistan Journal of Weed Science and Research 19: 1-14.

Kocher D K, Kaur R. 2007. Survey of rodent damage in sugarcane fields of Punjab and its control by rodenticidal baiting. Pestology 31(12): 40-43.

Mandal K G, Mishra A K, Hati K M, Bandyopadhyay S, Ghosh P K, Mohanty M. 2004. Rice residue management options and effects on soil properties and crop productivity. Journal of Food Agriculture and Environment 2: 224-231.

Sharma S N, Bohra J S, Singh P K Srivastava R K. 2002. Effect of tillage and mechanization on production potential of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. Indian Journal of Agronomy 47(3): 305-310.

Sidhu B S, Beri V. 2005. Experience with managing rice residues in intensive rice-wheat cropping system in Punjab. Conservation agriculture status and prospects. Abrol I P, Gupta R K, Malik R K (eds.), Centre for Advancement of Sustainable Agriculture (CASA), New Delhi, India. pp 55-63.

Singh P K, Prakash V, Srinivas A K, Srivastva R K. 2008. Effect of tillage management on energy-use efficiency and economics of soybean (*Glycine max*) based cropping systems under the rainfed conditions in North-West Himalayan region. Soil and Tillage Research 100: 78-82.

Singh R, Singla N, Kaur N. 2017. Determination of method and timings of rodent control in direct seeded and transplanted basmati rice crops. The Bioscan 12(2): 701-705.

Singh Y, Singh B, Timsina J. 2000. Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping systems in the tropics. Advances of Agronomy 85: 269-407.

Singla N, Babbar B. 2012. Critical timings of rodenticide bait application for controlling rodents in sugarcane crop grown in situations like Punjab. Indian Journal of Sugar Technology 14(1):76-82.

Singla N, Babbar B 2010. Rodent damage and infestation in wheat and rice crop fields: District wise analysis in Punjab state. Indian Journal of Ecology 307(2): 88-184.

TimsinaJ, Connor D J 2001. Productivity and management of rice-wheat cropping systems: Issues and challenges. Field Crop Research 69: 93-132.

Uri N D. 1999. Perception on the use of no-till farming in production agriculture in the United States: an analysis of survey results. Agriculture, Ecosystem and Environment 77(3): 263-266.

(Manuscript Received: April, 2022; Revised: July, 2022; Accepted: July, 2022; Online Published: July, 2022) Online First in www.entosocindia.org and indianentomology.org Ref. No. e22221