J. Trop. Plant Pests Dis.
Vol. 25, No. 2, September 2025
Pages: 208–217

ISSN: 1411-7525
E-ISSN: 2461-0399
DOI : 10.23960/j.hptt.225208-217

RESEARCH PAPER

Identification of bird pests on several sorghum genotypes during the rainy season, in Gunung Kidul, Indonesia

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Manuscript received: 7 November 2023. Revision accepted: 3 March 2025. Available online: 4 July 2025.

ABSTRACT

Birds are among the most significant vertebrate pests affecting sorghum crops worldwide, particularly in community farming systems. Their attacks can lead to substantial yield losses, especially during the grain ripening stage. This study aimed to identify the species, number of individuals, attack frequency, extent of crop damage, and control efforts related to bird pests in sorghum cultivation. The research was conducted from December 2022 to February 2023 in Karangmojo Village, Gunungkidul Regency, Yogyakarta, Indonesia. Six sorghum genotypes were planted: *bioguma* (V1), *plonco* (V3), *samurai* (V4), *kawali* (V6), *hitam wareng* (V8), and *ketan merah* (V9). However, observations were focused on *bioguma* and *plonco*, which experienced the most bird attacks. Three seed-eating bird species were identified: *Geopelia striata* (*kutut*, 156 individuals), *Lonchura leucogastroides* (*bondol jawa* or *emprit*, 375 individuals), and *Spilopelia chinensis* (*derkuku* or *tekukur*, 329 individuals). The peak bird activity occurred in the morning, with 47 attack events recorded in *bioguma* and 35 in *plonco*. The average crop damage reached 1.26% in *bioguma* and 1.24% in *plonco*, resulting in estimated yield losses of Rp. 922,140.00 and Rp. 750,360.00 per ha, respectively. Control measures employed by farmers included the use of perforated plastic hoods and safety nets, though their effectiveness was limited.

Key words: Bioguma, birds pests, Gunungkidul, plonco, rainy season, sorghum

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the world's most important cereal crops, rangking fifth after wheat, maize, rice, and barley in global production (McCormick, 2020). In South Africa, it is the third most important grain after maize and wheat. Globally, sorghum production has reached approximately 64.20 million metric tons, cultivated across 41 million ha of land (Vijayakumar et al., 2014). Africa contributes around 26 million metric tons of thistotal, with Nigeria, Ethiopia, Burkina Faso, and Niger being continent's top producers. In Africa, nearly 74% of sorghum is used for direct human consumption (AATF, 2021, USDA, 2025).

Sorghum is generally classified into two categories: wild and domesticated. Wild sorghum includes species such as *Sorghum halepense*, *Sorghum propinquum*, *Sorghum bicolor* subsp. *drummondii*, and *Sorghum bicolor* subsp. *verticilliflorum*. Cultivated sorghum varieties are grouped into five major races, bicolor, caudatum, durra, guinea, and kafir, as well as ten intermediate races, based on panicle and spikelet morphology (Buschmann, 2018; Chakrabarty et al., 2022). In South Africa, the *kafir* race is believed to be the result of introgression between cultivated and wild sorghum species (Mofokeng & Shargie, 2016).

Sorghum is known for its high drought tolerance and ability to thrive in marginal environments where other crops may fail. However, its productivity is significantly affected by both biotic and abiotic stressors. One of the most pressing biotic constraints is damage caused by bird pests, which represents a major global challenge in grain production (Cell Press, 2019 ; USDA APHIS, 2024).

Birds typically attack sorghum crops during the soft dough stage, when the grains are rich in sugary juice and vulnerable to feeding (Mofokeng & Shargie, 2016; Mutisya et al., 2016). Several bird species, including parrots, sparrows (*Passer domesticus*), *Quelea quelea*, crows, *Volatinia jacarina, Patagioena spicazuro, Aratinga leucophthalma*, and *Columbina talpacoti,* have been documented to damage sorghum field (Dinas Pertanian Buleleng, 2020; Kharisma, 2024). These birds can cause yield losses ranging from 10% to 80%, especially when attacking in large flocks. Significant damage often occurs during the early and late blooming stages, with sparrows, baya weavers,

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and rose-ringed parakeets accounting for up to 52% of yield losses in some areas (Dinas Pertanian Buleleng, 2020, Kharisma, 2024).

Among these bird pests, the rose-ringed parakeet (*Psittacula krameri*) is reported to be one of the most destructive, causing considerable damage not only to grain crops but also to fruit orchards and vegetable fields (Reddy et al., 2022). Notably, the extent of crop damage caused by birds is often greater than that caused by insect pests, highlighting the urgency of effective bird control strategies.

This study was conducted to investigate the impact of bird pests on different sorghum genotypes during the rainy season in Gunung Kidul, Indonesia. Specifically, it aimed to identify the bird species involved, quantify their attack frequency and resulting damage, and evaluate the control measures employed by local farmers to mitigate bird-induced losses.

MATERIALS AND METHODS

Research Site. The study was conducted in sorghum fields located in Karang Duwet Hamlet, Karangmojo Village, Gunungkidul Regency, Yogyakarta, Indonesia (coordinates: 7°57'41.2"S 110°41'34.2"E", altitude 95.0 m, above sea level). The research took place during the first planting season, from December 2022 to February 2023.

Experimental Design. Observations were carried out in a 1000 m² field divided into plots representing different sorghum growth stages: <70 days; 70–120 days, and >120 days. Six sorghum genotypes were planted in the research area: *Bioguma* (V1), *Plonco* (V3), *Samurai* (V4), *Kawali* (V6), *Hitam Wareng* (V8), and *Ketan Merah* (V9). However, data collection focused on *Bioguma* (a superior variety) and *Plonco* (a local variety), as these were the most frequently attacked by bird pests.

Data Collection. Two types of data were collected: primary data and secondary data.

Primary Data. Primary data included: 1) Number of individual birds observed per species; 2) Frequency of bird attacks on sorghum plots; 3) Number of intact and damaged panicles per clump; 4) Weight of intact and damaged grains; 5) Bird control measures employed by farmers. In addition, information was collected on the control measures farmers took to overcome bird attacks.

Secondary Data. Secondary data included general enviromental and site characteristics, obtained through literature review and interviews with local farmers.

Observation Schedule and Method for Birds Attacks. Direct field observations were used to quantify bird presence and behavior, employing the concentration count method. Observations were made in wetland areas near community settlements. Bird presence and attacks were recorded at three time intervals each day: 07:00–9:00 (morning); 11:00–13:30 (noon); and 15:00–17:00 (afternoon).

Each time interval was replicated seven times across the observation period. The number of individual birds entering each plot was recorded, and the average bird population was calculated for each time interval. Simultaneously, the frequency of attacks and the identity of bird species were recorded. The identification of crop damage was conducted during or immediately after attack events.

Bird Species Identification. Bird species were identified using the following tools: tally sheets and writing instrumens, timer (clock), digital camera (Canon SX 400 IS), binoculars (Nikon Action 10 x 40 mm), digital weighing scale (QC PASS 500g/0.1 g), measuring tape (50 m), scissors, plastic specimen containers, bird identification guidebook by Eaton et al. (2021), and laptop for data entry and processing.

After an attack occurred, observers immediately visited the affected plot to count the number of intact and damaged panicles. The grain weight of five randomly selected intact panicles was recorded to establish a baseline. The weight of grains from attacked panicles was then measured to determine losses.

Assessment of Damage to Sorghum. Crop damage was assessed based on both panicle condition and grain weight. The number of intact and damaged panicles was recorded, and losses were calculated using the following formulas:

$$P = \frac{b}{a} \times 100\%$$

P = Panicle damage (%);
a = Total number of panicles;
b = Number of damaged panicles.

$$G = \frac{y}{x} \times 100\%$$

G = Grain weight loss (%);
y = Total weight of intact panicles;
x = Total weight of attacked panicles.

Bird control strategies were documented through field observations and interviews with farmers regarding their preventive measures and experiences managing bird pest attacks.

RESULTS AND DISCUSSION

Bird Species. Three bird species were identified as pests in the sorghum fields: *kutut* (*Geopelia striata*), *bondol jawa* (*Lonchura leucogastroides*), and *derkuku* or *tekukur* (*Spilopelia chinensis*) (Figure 1). These granivorous birds are characterized by their small body size, short tails, and stout beaks adapted for seed consumption. Their tendency to form flocks and feed collectively makes them particularly destructive in sorghum fields (Eaton et al., 2021).

Bird Activity Patterns

Bioguma Plot. In the Bioguma plot, *bondol jawa* was the most dominant species observed, with a total of 670 individuals recorded during 48 days of observation. Specifically, 375 individuals were identified as *bondol jawa*, followed by 329 *tekukur* and 156 *kutut* (Table 1). The highest attack intensity occurred in 120-day-old plants, coinciding with the grain ripening stage. This stage presented soft grains that had not fully hardened, making them attractive to seed-feeding birds.

Morning was the peak period of attack, with 225 *bondol jawa* individuals observed. The extended vegetative phase due to rainy conditions delayed seed maturity, increasing the vulnerability of sorghum to bird attacks. In contrast, sorghum varieties with red or black grains were attacked less frequently, likely due to their higher anthocyanin content, which may act as a deterrent (Xie et al., 2019).

The proximity of nesting sites—such as mango and Chinese petai trees—also influenced bird activity by providing nearby shelter (Fitri et al., 2014; Hidayatullah, 2015). Bird presence was generally higher in the morning, potentially due to reduced human activity during that time, as reported by Tunggul (2023).

Plonco Plot. In the Plonco plots, a total of 97 individual birds were recorded throughout the 48-day observation period, with the highest frequency of attacks occurring in plots aged 70–90 days, totaling 52 bird visits (Table 2). *Spilopelia chinensis* (*tekukur*) infestations were lower than in the Bioguma plots and were only observed in the morning and midday during this plant age stage. These findings are consistent with Cristanti & Arisoesilaningsih (2013), who reported that *bondol jawa* birds tend to attack sorghum crops during the milk and grain ripening stages, when the grains are still soft and more palatable.

The overall number of bird attacks in Plonco was relatively low compared to Bioguma. This lower intensity is likely due to Plonco's shorter plant stature, which may disrupt bird landing and feeding behavior, as well as the lower palatability or attractiveness of Plonco grain compared to Bioguma.

Within the 70–90 day age range, afternoon hours saw the most frequent attacks, with 19 individual visits recorded. The average number of birds attacking in

Table 1. Number of individual birds per species observed at different times of day in Bioguma plots over 48 days

Plant age (days)	Bird species	Morning	Noon	Afternoon	Total	Rate per 7 days
>90	*L.leucogastroides*	225	80	70	375	93.8
	G. striata	70	45	41	156	39
	S. chinensis	139	112	78	329	82.3
	Total	434	237	189	860	215.1
70	*L.leucogastroides*	30	15	10	55	13.8
	G. striata	20	10	5	35	8.8
	S. chinensis	35	20	15	70	17.5
	Total	85	45	30	160	40.1
70-90	*L.leucogastroides*	120	70	50	240	60
	G. striata	50	40	30	120	30
	S. chinensis	55	35	29	119	29.8
	Total	225	145	109	479	119.8

Observations were conducted three times daily (morning, noon, afternoon) for 48 days. The rate per 7 days reflects weekly average bird presence.

the afternoon was 7.4 birds per observation (Table 2). In contrast, for other plant age groups, morning was the more active period for bird visits, with an average number of attacking birds ranging from 3.9 to 2.6.

This temporal pattern is likely influenced by human activity in the surrounding area. In the morning and afternoon, farmers are often present in the fields, which can deter bird activity. However, afternoon hours tend to have fewer human disturbances, allowing birds to forage more freely. Additionally, cloudy or shaded environmental conditions in the afternoon may provide a more favorable microclimate for bird activity.

Frequency of Bird Attacks

Bioguma Plot. During the 48-day observation period, a total of 370 bird attacks were recorded in the Bioguma plots (Table 3). The highest frequency of attacks occurred at midday (139 times), followed by the afternoon (121 times) and the morning (110 times). The species most frequently observed was *bondol jawa* (*Lonchura leucogastroides*), with the greatest number of attacks—98 occurrences—taking place in 120-day-old sorghum plots.

Between 70–90 days of plant age, the most notable *bondol jawa* activity was also recorded at midday,

Table 2. Number of *bondol* species individuals observed at different times of day in Plonco plots over 48 days of observation

Plant age (days)	Bird species	Morning	Noon	Afternoon	Total	Rate per 7 days
< 70	*L.leucogastroides*	10	5	8	23	3.3
	G. striata	0	3	1	4	0.6
	S. chinensis	0	0	0	0	0
	Total	10	8	9	27	3.9
70–90	*L.leucogastroides*	12	10	7	29	4.1
	G. striata	7	3	10	20	2.9
	S.chinensis	1	0	2	3	0.4
	Total	20	13	19	52	7.4
> 90	*L.leucogastroides*	7	4	5	16	2.3
	G. striata	2	0	0	2	0.3
	S. chinensis	0	0	0	0	0
	Total	9	4	5	18	2.6

Observations were conducted three times per day across different sorghum growth stages over 48 consecutive days. Rate per 7 days represents the weekly average number of bird individuals recorded per species.

Table 3. Frequency of bird infestations in Bioguma sorghum plots at different times of day over 48 days of observation

Plant age (days)	Birds species	Morning	Noon	Afternoon	Total
< 70	*L.leucogastroides*	33	18	22	73
	G. striata	5	21	27	53
	S. chinensis	7	15	17	39
70–90	*L.leucogastroides*	5	12	11	28
	G. striata	3	0	10	13
	S. chinensis	4	12	0	16
90	*L.leucogastroides*	28	47	23	98
	G. striata	14	11	0	25
	S. chinensis	11	3	11	25
	Total	110	139	121	370

Frequency refers to the number of bird attack events observed during three daily time intervals across 48 days. Data represent individual bird group visits, not the number of individual birds.

totaling 12 attacks. Although birds were active throughout the day, the morning period also showed consistently high attack frequency, especially in cloudy weather conditions. This contrasts somewhat with the findings of Biaou, 2020 who reported that *bondol* birds predominantly attack in shady conditions. While this study confirms their preference for low-light environments, such as overcast mornings, it also reveals greater variability in the timing of attacks—likely influenced by local weather patterns and food availability. Nonetheless, the tendency for group attacks remained consistent with previous reports.

Plonco Plot. Comparison with the Plonco plots reveals distinct differences in bird attack patterns. Over the same observation period, 190 attacks were recorded in Plonco, with the highest frequency occurring in the afternoon (89 times), followed by the morning (76 times), and midday (25 times) (Table 4). Bondol Jawa was again the dominant species, responsible for 98 attacks in this location. The most intense activity occurred in the 70–90-day-old sorghum plots, where 44 attacks were recorded in the afternoon. The elevated attack rate during morning and afternoon periods in Plonco is likely due to environmental shading and human activity patterns. During cloudy weather and light drizzle—common in the mornings—birds were more actively foraging. The relatively shaded conditions of the afternoon further supported higher activity, consistent with reports by Biaou, 2020, who found that *bondol* birds prefer shaded environments and exhibit collective foraging behavior.

Sorghum Damage Rate

Bioguma Plot. Sorghum plants older than 90 days in the Bioguma plot experienced the highest level of panicle damage and yield loss, particularly during morning hours (Figure 1). Prolonged grain ripening and frequent bird activity resulted in broken panicles and grain loss. These findings are consistent with Mofokeng & Shargie (2016) and supported by the role of climatic factors—such as temperature, solar radiation, and rainfall—in the seed-filling phase (Prasad et al, 2015), The structural traits of the panicle, including void percentage and grain density, also affected the level of damage (Das et al., 2018; Hardiansyah et al., 2023).

Among the bird species, *bondol jawa* caused the most significant damage. These birds are capable of

Table 4. Frequency of bird attacks in Plonco sorghum plots during 48 days of observation

Plant age (days)	Birds species	Morning	Noon	Afternoon	Total
< 70 days	*L.leucogastroides*	14	2	12	28
	G. striata	10	3	11	24
	S. chinensis	10	0	10	20
70-90	*L.leucogastroides*	23	6	15	44
	G. striata	15	4	12	31
	S. chinensis	1	0	13	14
90	*L.leucogastroides*	1	8	16	25
	G. striata	2	1	0	3
	S. chinensis	0	1	0	1
	Total	76	25	89	190

Attack frequency refers to the number of bird group visits observed during three daily time intervals over 48 consecutive days.

Figure 1. Bird species observed in the sorghum field during the 48-day study. A. *Geopelia striata* (*kutut*); *Lonchura leucogastroides* (*bondol jawa*); C. *Spilopelia chinensis* (*derkuku*). Identification based on Eaton et al. (2016).

consuming up to 14% of their body weight in grains daily Biaou, (2020). Their group feeding behavior and ability to attack multiple panicles in a single visit contributed to substantial yield loss.

The Bioguma variety has a potential yield of 9.3 tons/ha (Rasma et al., 2025). Yield losses due to bird attacks in this study averaged 1.26%, with the highest losses in 70–90-day-old plants (0.49%), followed by plants older than 120 days (0.41%), and the least in plants under 70 days old (0.36%) (Table 5). These losses were lower than those caused by major pests such as rodents (20%) (Djodda et al, 2019), stem borers (30%) (Divya et al., 2010), and brown planthoppers (28%) (Horgan et al., 2021).

Plonco Plot. In the Plonco plots, the highest panicles and grain weight damage occurred in 70–90-day-old plants during the afternoon (Figure 2). This was due to the fact that in the afternoon there were relatively few disturbances experienced by the *bondol* birds from the activities of farmers, communities, and schoolchildren, so the plots were more likely to experience attacks by bondol birds. In addition, temperature, solar radiation, and rainfall are climatic factors that affect the seed filling phase. The seed filling phase is a very critical phase because of the translocation of photosynthetic assimilates to the seeds.

The results of photosynthetic energy (carbohydrates), translocation, and accumulation in the grain determine the level of grain filling. The differences that exist in the level of damage to panicles and weight in plots aged more than 90 days are thought to be the result of differences in panicle length, percentage of void, and sparse grains in each panicle. Each attacked panicle has sparse grains. Therefore, there is a difference between the level of damage to panicles and their weight in plots older than 90 days. At the time of my observation in the afternoon, the condition of the research site was often cloudy and rainy. This made the conditions around the research plots shadier. Bird attacks were more common in the afternoon. Yaqub (2022) and Tunggul (2023) also stated that birds usually attack in shady weather conditions. In this plot, the Peking sparrow was the most common bird species observed to attack in the afternoon (Mofokeng & Shargie, 2016). During the study, the average damage

Figure 2. Picture Plonco plots damaged, collection researcher photo

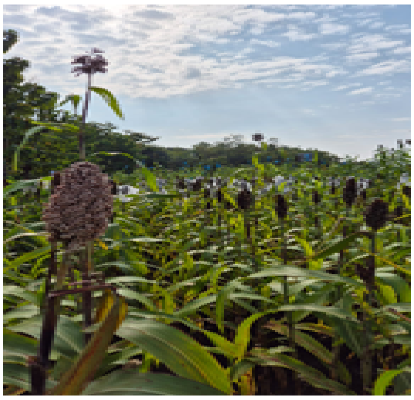

Table 5. Percentage of damage to Bioguma sorghum plants during 48 days of observation

Plant age (days)	Panicle Damage (%)	Grain Weight Loss (%)	Average total damage (%)
< 70	0.20	0.16	0.36
70–90	0.26	0.23	0.49
> 90	0.24	0.17	0.41
Average	—	—	1.26

Table 6. Percentage of damage to Plonco sorghum plants during 48 days of observation

Plant age	Panicle Damage (%)	Grain Weight Loss (%)	Average total damage (%)
< 70	0.18	0.18	0.36
70–90	0.25	0.24	0.49
> 90	0.23	0.16	0.39
Average	—	—	1.24

to sorghum plants by birds in Plonco plots was 1.24 % (Table 6). The amount of damage was also smaller compared to three other pests, such as field mice at 20% (Mubarok, 2021), stem borers at 30% (Divya et al, 2010), and brown planthoppers at 28% (Hu et al., 2014., Wu et al., 2018).

Estimated Economic Losses

Bioguma Plot. Observations from five replications showed an estimated economic loss of Rp. 922,140.00 per ha due to bird attacks in the Bioguma plots (Table 7). This estimate was based on the average yield reduction and the market price of dried sorghum (Rp. 6,000/kg).

Plonco Plot. Similarly, estimated losses in Plonco plots were Rp. 750,360.00 per hectare (Table 8), slightly lower than those observed in Bioguma, reflecting the reduced attack frequency and damage intensity.

Bird Pest Control Efforts. Farmers attempted to control bird pests by installing nets and using plastic bags to cover panicles during the seed ripening stage. These methods were intended to minimize bird access without disrupting the seed drying process. However, moisture buildup from rainfall led to mold growth, prompting removal of the plastic covers. BRIN (National Research and Innovation Agency of Indonesia) provided protective nets, but due to high installation costs, coverage was limited and insufficient.

Table 7. Losses due to *bondol* bird pests in Bioguma plots during 48 days of observation

Plant age (days)	Price/kg (Rp)	Birds species	Plot area (m^2)	Yield total (kg/m^2)	Yield (kg/ha)	Total Lost (Rp/ha)
< 90	6000	*L.leucogastroides*	1.3	0.0052	69.84	419,040
		G. striata	2.3	0.0056		
		S. chinensis	3.4	0.0086		
		Total	7.0	0.0194		
70–90	6000	*L.leucogastroides*	0.1	0.0050	45.68	274,080
		G. striata	1	0.0046		
		S. chinensis	1.1	0.0045		
		Total	2.2	0.0141		
90	6000	*L.leucogastroides*	0.2	0.0031	38.17	229,020
		g. striata	0.9	0.0039		
		S. chinensis	0.2	0.0038		
		Total	1.3	0.0108	153.69	922,140

Table 8. Losses due to *bondol* bird pests in Plonco plots during 48 days of observation

Plant age (days)	Price/kg (Rp)	Birds species	Plot area (m^2)	Yield (kg/m^2)	Yield total (kg/ha)	Total Lost (Rp/ha)
< 70	6000	*L.leucogastroides*	1.2	0.00433		
		G. striata	3.6	0.0968	68.62	411,720
		S. chinensis	0.5	0.0200		
		Total	5.3	0.1211		
70–90	6000	*L.leucogastroides*	1.4	0.0050		
		G. striata	2.9	0.0026	34.07	204,420
		S. chinensis	1.6	0.0035		
		Total	5.9	0.0111		
> 90	6000	*L.leucogastroides*	1.4	0.0021	22.37	134,220
		g. striata	0.6	0.0019		
		S. chinensis	0.7	0.0028		
		Total	2.7	0.0068	125.06	750,360

Nets were installed only on the edges of the plots and not actively monitored by farmers, reducing their effectiveness.

CONCLUSION

This study identified three species of sorghum seed-eating birds: *kutut* (*Geopelia striata*, 156 individuals), *bondol jawa* (*Lonchura leucogastroides,* 375 individuals), and *derkuku* or *tekukur* (*Spilopelia chinensis,* 329 individuals). A total of 860 bird attacks were recorded in the Bioguma plots and 190 attacks in the Plonco plots, with the morning (07:00–09:00) identified as the peak attack period. The recorded crop damage reached 1.26% in Bioguma and 1.24% in Plonco, resulting in estimated economic losses of Rp. 922,140.00 and Rp. 750,360.00, respectively. Bird activity was highest in the morning and late afternoon (15:00–17:00 PM), suggesting these time intervals are optimal for implementing control strategies. While farmers attempted preventive measures such as plastic hoods and protective netting, these methods had limitations—particularly in terms of moisture buildup and incomplete coverage. The study highlights the urgent need for improved bird management strategies, such as optimized net installations and alternative bird deterrents, to reduce economic losses and support sustainable sorghum production.

ACKNOWLEDGMENTS

We would like to express our sincere gratitude to the Research Organization for Agriculture and Food, Research Center for Food Crops, National Research and Innovation Agency (BRIN), for their support and encouragement throughout the research. We also extend our appreciation to all individuals and parties who contributed to this study, but cannot be mentioned individually.

FUNDING

This funding was funded by the National Research and Innovation Agency (BRIN), Indonesia.

AUTHORS' CONTRIBUTIONS

All authors contributed significantly to this study, including field observations, data collection, data analysis, manuscript writing, literature review, critical revisions, and final approval of the submitted version.

COMPETING INTEREST

The author declare no competing interests related to the research, authorship, or publication of this article.

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