African Journal of Agricultural Research Vol. 7(32), pp. 4575-4580, 21 August, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR11.1811
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Effectiveness of mesh netting and nest' destruction in protection of crops against attack by Spanish sparrow *Passer hispaniolensis*

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Accepted 4 June, 2012

Many developing countries are rich in natural resources such as high quality, cultivated land, but still depend on imports to meet domestic demand for basic products. One of the factors constraining production of cereal crops in many countries is the damage caused by seed-eating birds such as sparrows. The aim of this study was to test the effectiveness of two methods, deployment of netting and destruction of sparrow nests, in protecting crops and decreasing harvest losses. In two years (2006 and 2009), potential wheat yield and sparrow damage were assessed in two experimental plots of wheat plus a third control plot. The average percentage of ears attacked by the Spanish sparrow in the control plot was 62±4.9%. This was significantly higher than the levels of sparrow damage in the nest destruction plot (35±2.3%) and the plot protected by netting (1.4±0.35%). The theoretical yield was estimated to be 1452±180 kg/ha in the control plot, 1318±126 kg/ha in the nest destruction plot, and 1928±117 kg/ha in the netting plot. This study demonstrates that yield losses of Algerian wheat can be substantially reduced using simple and cost-effective techniques.

Key words: Spanish sparrow, nests destruction, loss, wheat.

INTRODUCTION

Although Algeria is a very rich country with natural resources and agricultural potential (19.8% of the total area is arable, Algerian Statistics, 2009), the country is still struggling for its own consumption. The average annual yield per unit area of wheat crop in Algeria is only 1650 kg/ha (Ministry of Agriculture, 2010). As a consequence, Algeria still imports huge amounts of agricultural products, where basic products like cereals, vegetables and sugar are the major imported products. While cereals occupy an important part in the Algerian diet (60% of the average food intake), the local production of wheat estimated to almost 3 million tons in 2007 covers only one third of the domestic market (Djaouti, 2010). It seems that with the abundance of natural resources, their management and wise use are the missing keys for a sustainable economics of the country.

Some natural factors were also assessed as constraints in this agricultural production, mainly in the cereal production. Sparrows (*Passer* sp.) play an important role in the registered yield losses (Ait Belkacem et al., 2007; Mezenner, 1989; Behidj, 1998). Siriez (1967) stated that a single sparrow can consume between 2.5 and 4.7 kg of seeds of cereals per year. In Algeria, the sparrow hybrid (*Passer domesticus* x *Passer hispaniolensis*) has entered the list B of the Executive Decree No. 95-387 of the 28th November 1995, concerning the species detrimental to agriculture, because of its voracity and its reproduction rate (Guezoul et al., 2010). In general, about 75% of the trophic regime of the house sparrow (*P. domesticus*) is constituted by

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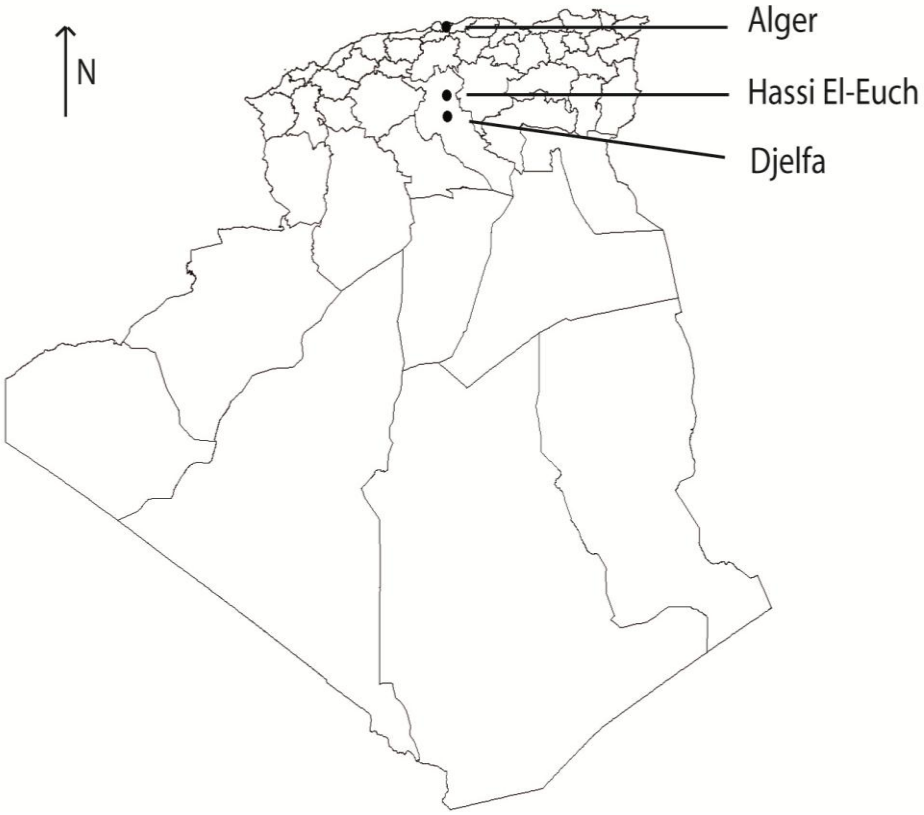

Figure 1. Geographical position of the region of Hassi El-Euch in Djelfa.

plants (Géroudet, 1984). Bortoli (1969) reported that the Spanish sparrow (*P. hispaniolensis*) has a preference for seeds of crops like soft wheat, hard wheat, barley, oats and rice and wild plants such as amaranth. While Koudjil (1982) noted that Poaceae were the most ingested by three species of sparrows.

Sparrows are considered a serious problem in some areas in Algeria, and there have been many studies on the damage caused by sparrows to cultivated crops (Bachkiroff, 1953; Berville and Gauthier, 1961). Losses attributed to attacks by sparrows in cereals have been estimated to range between 50 and 390 kg/ha for hard wheat, and between 155 and 450 kg/ha for barley (Bellatreche, 1979; Metzmacher and Dubois, 1981; Madagh, 1996). Sometimes, these losses were even as high as 613 kg/ha for hard wheat and 1895 kg/ha for barley (Ait Belkacem et al., 2007). Other researchers also evaluated the losses for other plant species susceptible to sparrow, e.g. date fruits. Indeed, Guezoul et al. (2010) estimated that losses in the region of Ouargla (Algeria) may reach 510 kg/ha (the equivalent of 8.3% of the yield).

A wide variety of protection methods has been used in attempts to decrease the losses faced by the farmers in the High Plateau of Algeria. The aim of this study was to determine the efficiency of two alternative methods of protection against the Spanish sparrow on cereals, and the effects of these methods on yield losses.

MATERIALS AND METHODS

Study area

The study was carried out at the station of Hessi El-Euch (35°9' North; 3°14' East, 910 m. a. s. l) in the region of Zehrez. Hessi El-Euch is an area of 509.14 km^2, located at 275 km in the south east of Algiers (Algeria, Figure 1). With a cool winter and precipitations ranging from 217 to 337 mm (mean values from the years 2006 and 2009, respectively), the region is categorized as semi-arid. In this station, wheat (*Triticum durum*) is traditionally cultivated on an area of 250 ha. The field is bordered by bushes of jujube (*Zyziphus lotus*), which are used by the Spanish sparrows as nesting sites during fall and summer.

Experimental design

From the wheat parcel, three plots of 1 ha each were selected at an equidistance from the nesting site (29 jujube bushes). The plots were later divided into nine units of replication (blocs) of 0.1 ha each (Figure 2). The plots represent the different treatments; plot 1 (P1): protected by a mesh, plot 2 (P2): destroyed nests and plot 3 (P3): unprotected (neither a mesh has been put, nor have the nests been destroyed). The mesh (polyethylene high density, 20 × 100 m,

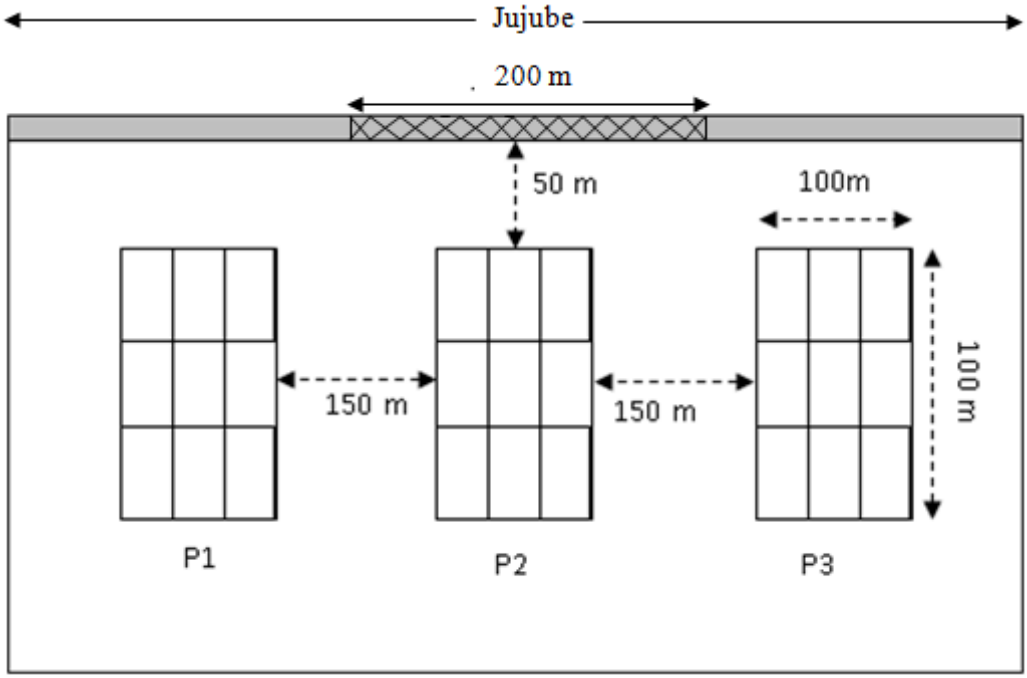

Figure 2. Position and limits of the plots.

Figure 3. Nesting site and nest destruction in the station of Hassi El-Euch (Djelfa).

with small regular mesh of 2.5 × 2.5 cm) was installed one week after wheat tillering. It was fixed on wooden supports, separated at 5-m intervals to cover the whole plot. Nest destruction was done on 16 jujube bushes closest to the plot 2, on a total distance of 200 m (Figure 2) using converted poles. Breeding usually starts the first day of April, and the first laid eggs by the sparrows are observed by the 7th of April. Thirteen days after first egg laying, the first chicks normally hatch. The nests were destroyed ten days after hatching (30th of April), when approximately 50% of the chicks were ten days old, and before they were able to fly (13 to 15 days after hatching) (Figure 3). The total number of nests counted on the jujube bushes was 1116 and 1207 in 2006 and 2009, respectively. While the total number of nests destroyed was 883 and 1052 during the two aforementioned years, which represent 79 and 87% of the total nests. The number of destroyed nests varied among the bushes and between the two experimental years. The efficiency of nests destruction is related to the bush height and their accessibility.

Measurements

The method of the “Greek throw” was used in order to estimate the

Table 1. Losses rate due to Spanish sparrows during 2006 and 2009, and their averages, after mesh protection (p), destroyed nests (nd) against unprotected (up) plots.

Treatment year	Parameter	up	nd	p	P-values		
					Year	Treatment	Year × Treatment
First year	P (%)	63.2±5.8[a]	36.6±2.2[b]	1.33±0.39[c]		<0.001	
	TY (kg/ha)	1481±212[b]	1300±143[c]	1886±127[a]		<0.001	
	TLB (kg/ha)	734±130[a]	358±41[b]	24.4±7.0[c]		<0.001	
	TLRB (%)	49.4±10.2[a]	27.5±3.6[b]	1.3±0.2[c]		<0.001	
Second year	P (%)	61.5±3.8[a]	34.1±1.6[b]	1.33±0.31[c]		<0.001	
	TY (kg/ha)	1423±147[b]	1337±112[c]	1971±93[a]		<0.001	
	TLB (kg/ha)	731±145[a]	312±45[b]	26.0±3.4[c]		<0.001	
	TLRB (%)	53.7±8.5[a]	24.3±2.0[b]	1.3±0.3[c]		<0.001	
Two years	P (%)	62.3±4.9[a]	35.4±2.3[b]	1.39±0.35[c]	0.084	<0.001	0.481
	TY (kg/ha)	1452±180[b]	1318±126[c]	1928±116[a]	0.591	<0.001	0.329
	TLB (kg/ha)	733±134[a]	335±48[b]	25.2±5.4[c]	0.485	<0.001	0.647
	TLRB (%)	51.6±9.4[a]	25.9±3.3[b]	1.30±0.2[c]	0.819	<0.001	0.145

[a-c]Mean values within the same row sharing no common superscript are significantly different (P < 0.05) after comparison of the means by the Tukey's procedure. P (%): proportion of attacked ears; TY: theoretical yield; TLB: theoretical losses and TLRB: theoretical loss rate due to birds. Mean values are reported with the standard errors.

damage (Doumandji and Doumandji-Mitiche, 1994). It consists of throwing a square piece of wood (0.5 x 0.5 m^2) randomly in each block, and then proceeding to a quantification of the biomass. This was done by counting the sound ears separately from the attacked ones (including bird and insect attacked ears). Then 10 ears were randomly sampled within each square sampled. The whole operation (the Greek throw and the quadrate count) was repeated 3 times successively. The selected ears were put in paper bags, sealed and labeled before being sent to the laboratory. In the laboratory, the following parameters were evaluated: number of existing and lacking grains on the ears, average of grains by ear, and average weight of one grain (by weighing 1000 grains) (Doumandji and Doumandji-Mitiche, 1994).

Calculations

The proportion of attacked ears by the birds was given following Doumandji and Doumandji-Mitiche (1994) as:

$$P(\%) = (ANAE \times 100)/ANE \quad (1)$$

With ANAE being the average number of ears attacked by birds within 0.25 m^2 and ANE, the average number of ears within 0.25 m^2.

Theoretical loss (kg/ha) due to birds (TLB) was calculated according to Doumandji and Doumandji-Mitiche (1994) as:

$$TLB = ANAE \times ANAG \times AWSG \times 0.4 \times 100 \quad (2)$$

With ANAG, the average number of attacked grains in an ear and AWSG, the average weight of a sound grain (in grams).

Theoretical loss rate due to birds (TLRB) was estimated as the ratio of the theoretical loss due to birds (TLB) to the theoretical yield (TY) multiplied by 100 (Doumandji and Doumandji-Mitiche, 1994):

$$TLRB = TLB \times 100 / TY \quad (3)$$

The theoretical yield (kg/ha) was calculated by extrapolation of the total weight of grains present in the 0.25 m^2 sampled area:

$$TY = ANE \times ANEG \times ASWG \times 0.4 \times 100 \quad (4)$$

with ANEG as the average number of grains by ear.

Statistical analysis

Data from both experimental years were subjected to analysis of variance using the GLM procedure of SAS (Version 9.1, SAS Institute Inc., Cary, NC) with treatment as the main effect. Multiple comparisons among means were made by Tukey's procedure. Table 1 gives arithmetic means and standard errors. For the combined effect during both experimental years, data were analyzed by performing repeated measurement analysis using the MIXED procedure of SAS. Effects considered were treatment, year and the interaction between the two factors. Table gives least square means, standard error and P-values. Multiple comparisons among the means were performed by Tukey's method both for treatment and year.

RESULTS AND DISCUSSION

The proportions of attacked ears, theoretical yield, theoretical losses and loss rates due to birds during the two experimental years (2006 and 2009) are presented in Table 1.

Both treatments (nest destruction and protection with the mesh) had a significant positive effect on the tested parameters (P<0.001) for both years (2006 and 2009). Both treatments significantly decreased (P<0.001) the proportion of attacked ears from 62% in the unprotected

plot to 35% after nest destruction and to only 1.4% after protection with the mesh. This was reflected by significant decreases in the theoretical losses and in the theoretical loss due to birds. Protection by mesh significantly increased ($P<0.001$) the theoretical yield by 33% compared to the unprotected plot. However, the theoretical yield was not improved by the nest destruction. The results were similar in both experimental years (Table 1), without a significant effect of the year on all the measured parameters ($P>0.05$).

From these numbers, the percentage of attacked ears, the quantities of theoretical losses and the rates of losses due to birds were significantly reduced by the technique of protection with a mesh. Actually, the mesh prevented the sparrows from access to the plot. Losses were greater in the plot where nests have been destroyed than in the protected plot by mesh. These losses were mainly caused by the attacks of adult sparrows. However, the high rate of losses in the unprotected plot, compared to the two other plots, can be explained by the presence of both adults and their fledged chicks. The results obtained confirmed those reported by Bellatreche (1983), Behidj and Doumandji (1996) and Madagh (1996), who stated that the average of losses of wheat yield caused by sparrows in North Algeria, varies from 23 to 46%.

According to Manikowski and Dacamara-Smeets (1979), the losses are particularly related to the surroundings, like the presence of trees that offer a shelter from predators. Metzmacher and Dubois (1981) showed that damages caused by the sparrow varied mainly with the proximity of bird colonies, the plot surface, availability of water and the abundance of supports. According to Bortoli (1969), an individual sparrow can consume 300 g of grains during the harvest season. In Morocco, Bachkiroff (1953) stated that the damage caused by the Spanish sparrow can be more important than the damage caused by grasshoppers. According to Bouabdeli (2006), in the region of Hessi-El-Euch, the percentage of loss caused by the Spanish sparrows on the wheat fields averaged 24%. This fact can be explained by the strategic position of the plot. Indeed, the proximity of the trees to a source of water is the most favorable site for the Spanish sparrows to reproduce and nest.

The losses in the plot where nests have been destroyed were caused by the adults before the destruction of the nests. This strategy has been mentioned by Ruelle (1982), who stated that when nests were destroyed during their construction, they can be reconstructed by the males in the same location. However, when the destruction happens after laying, the parents leave the nesting site. So, it is inevitable to have some damage by the parents during the nest construction. According to Rabah (2002), the National Institute of Protection of the Plants and the Farming Office of Oran has tried the nest destruction technique using converted poles. The best timing for a successful protection by nest destruction was after the females lay their eggs and before chicks are able to fly. Furthermore, diet of chicks between 10 and 13 days-old is constituted mainly of arthropods (97%) (Akrouf et al., 2001). Therefore, leaving the chicks being fed until that age would contribute substantially in the protection of the crops against detrimental insects.

The usefulness of the protection methods in this study lies in using economic materials, and making the methods cost-effective, which can be adopted by the farmers. As an example, the net used in this study costs 88 Euros/ha. If we consider the theoretical yield gain by the netting (475 kg/ha compared to the unprotected plot) at a rate of 0.44 Euro/kg wheat, then the net gain from this method would be 121 Euros/ha. Although the nest destruction is much less expensive (0.1 Euro/nest), the gain cannot be considered here because of the loss in the theoretical yield compared to the unprotect plot.

Conclusion

This study showed that both nest destruction and netting can be used to successfully protect crops against Spanish sparrows. However, although both methods decreased crop damage, the crops protected by netting gave the highest predicted yields. The implementation of this protection method will be encouraged if there will be an economy of scale (costs of purchase, transport and installation), especially if the method is cost-effective from a preliminary analysis.

ACKNOWLEDGEMENTS

The authors acknowledge the technical support of the Institut National de Protection des Végétaux, El-Harrach, Algeria. The authors thank Abdelatif Bouabdelli, Salim Abidi and Kouider Zerouk for their help during the field work. Special thanks also go to Dr. Martin Paeckert, Curator of Birds, Senckenberg Naturhistorische Sammlungen Dresden (Germany), for his valuable correction.

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