Effects of Sunflower Cultivars and Different Sowing Dates on the Damage Rate Caused by Birds, in Particular House Sparrow *Passer domesticus*

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Received 24 December 2008; accepted 1 December 2009

Abstract: Field experiments were conducted in 2007 and 2008 to evaluate the impact of the House Sparrow *Passer domesticus* on the yield of Sunflower in Khoy, northwestern Iran. Three cultivars of sunflower (Alstar, Euroflor, and KSC43/128) were planted in four sowing dates with 15 day intervals. The results showed that the House sparrow has a significant impact on the yield of the tested cultivars. The damage rate reached 74.89%, 78.18% and 83.61% for the three cultivars; KSC43/128, Euroflor, Alstar respectively. The highest rate of damage was recorded for the first sowing date (86.05%) while the lowest was on the fourth date (75.63%). The results suggested that KSC43/128 was the most resistant to bird damage of the tested cultivars.

Keywords: Alstar, bird damage, Euroflor, House Sparrow, KSC43/128, *Passer domesticus*, sowing date, sunflower varieties.

INTRODUCTION

Sunflowers are the second most important source of vegetable oil in the world, after soybeans. Two types of sunflower are usually grown, those for oilseed production and those for the nut and birdfood markets; the former type is more attractive to birds around the world. Sunflower kernels are a favorite food of birds, particularly of House Sparrow, as these kernels contain many essential proteins and oils. In some areas like North America, where the maturity of sunflower seeds coincides with the post-egg-laying period when the nutritional demands of bird populations approach their annual peak, feeding the chicks and fledglings forces the adults forage throughout the day (Besser 1994). Here, the development of bird damage resistant sunflower cultivars may be an effective strategy toward the reduction of damage caused by Red-winged Blackbird *Agelaius phoenicens* to sunflowers (Mah *et al*. 1990). The ripening of sunflower seeds on the plant seed-head has a differential effect on the damage rates due to Red-winged Blackbirds, which prefers the seeds at the milky stage to those ripened. It seems that the birds are able to detach the hulls easily from kernels in the milky stage, and thus face less difficulty in accessing seeds and detaching the bracts inside the receptacles and florets. A flock of Red-winged Blackbirds usually causes more damage in September than a similar-sized flock in October. Fortunately, the size of flocks tends to be smaller in October than in September (Besser 1974).

To evaluate the levels of bird damage to sunflower, Samanci (1995) seeded sunflower cultivars of H894 (vulnerable to bird damage), Neagra, BRS1 de Cluj, and ND8016-15-1 (resistant to bird damage) in field experimental plots in Fargo Valley City, North Dakota, USA during three dates in mid June, 1986. For all sowing dates, H894 plants were damaged, whereas the damage to the resistant cultivars was reduced for later sowing dates. ND8016-15-1 was not significantly damaged, sowing date having no effect damage rates. The damage to H894 averaged 26% and to BRS1 4%. Samanci (1995) suggested proposed that higher proportions of seed kernels and seed oil in H894 probably made it more attractive to birds. During seed development, soft seeds suffered a damage rate of 76%. When the seeds were attaining the soft kernel stage, the numbers of birds reached a peak. It has therefore been suggested that most control attempts should be carried out during this short period. Scaring the birds away is certainly one of the most important ways of reducing bird damage during the first 18 days after anthesis (Cummings *et al*. 1989). Birch *et al*. (1982)

recommended early harvest as an approach to reduce bird damage rates. Khaleghizadeh *et al*. (2004) reported that it was mostly immature House Sparrow *Passer domesticus* that caused damage to the seeds in the doughy stage during August and September, while Rock/Feral Doves, *Columba livia* caused the main damage in October and November. Additionally, sparrow groups were larger in August than in September. However the present study was conducted to evaluate the yields of three sunflower cultivars and hybrids which had been recommended from the results of previous national projects as bird-damage resistant.

MATERIALS AND METHODS

The present study was based on a Split Plot Design and used a basic Randomized Complete Block Plan with three replicates located in the Agricultural and Natural Resource Research Station of Khoy, West Azerbaijan, northwestern Iran. The major plots had four different sowing dates (5 May, 20 May, 4 June and 19 June), and minor plots comprised three cultivars Alstar, Euroflor, and KSC43/128. Each cultivar was seeded in four rows, five metres in length and sixty centimetres distant from each other; seeds in a row had a separation distance of 25 cm. Two rows per plot had the sunflower heads covered by controls and were treated as controls. The other two rows were left uncovered and exposed, to allow study of the bird damage rate. House Sparrow damage rate was calculated based on the difference between the yields of the in exposed and control plots (Appendix I) at the end of the seed ripening period (Killi *et al*. 2004). The data were analysed using statistical software (SAS).

RESULTS

Results of the experiments in 2007

Based on the analyses of agronomical traits, the sowing dates and cultivars were significant factors in both sunflower yield and bird damage rate. The interaction between cultivar and sowing date was significant only for damage rate ($p<0.01$, Table 1). The results indicated that the highest yield was achieved from protected plots with the earliest sowing date. Much literature implies that reduction of seed yield relates to postponement of the sowing date. Nevertheless, the unprotected yields in the first and the fourth sowing dates were lowest and were positioned in the same statistical group. Unprotected yield was highest from the second sowing date. This indicates that the higher yields in the first sowing date treatments depend on effective measures against House Sparrow damage, otherwise the lowest yield will occur. By the second and third sowing dates, other food sources increasingly are available to birds, resulting in decreased damage to the crops. Table 2 demonstrates this well. When the House Sparrows have a wider choice of food available over a much wider area than just that of the crops, crop damage decreases. Of the studied cultivars, the hybrid Alstar suffered the most damage, while the hybrid KSC43/128 endured the least damage (Table 3). The results seem to indicate that cultivar damage rate was correlated with seed size; the larger size of KSC43/128 seeds makes it difficult for the birds to feed on them. Table 3 shows that the cultivar Alstar has the worst cultivar damage rate for all four sowing dates. Except for the second sowing date, the cultivar damage rates suffered by Euroflor are higher than those of the hybrid KSC43/128.

Results of the experiments in 2008

Based on results of Analysis of Variance of agronomical characteristics, sowing date and cultivar were related significantly to both plant yield and damage rate. The interaction between cultivar and sowing date was not significant for any of the measured characteristics ($p>0.05$, Table 1). The results of data related to the agronomical traits by Duncan's approach indicated that the highest protected yields were obtained from the first and second sowing dates were equal at 2,564 and 2,525 kg/ha respectively, no significant differences being obtained between the yields from the plants for these two sowing dates. With a postponement in sowing, the protected yield decreased. In the last sowing date, the least seed yield obtained was 1,958 kg/ha (Table 2). In practice, the highest protected yield was obtained from the earliest sowing date, the seed yield decreasing with sowing date delay. However, unprotected yield was least for the first sowing date (101 kg/ha), and with postponement of sowing date, the yield then increased. Because limited food sources are available to birds at early sowing dates, House Sparrow damage to unprotected sunflower crops, especially early-ripening cultivars, was highest at this time, thus indicating that the absence of any protective measures against bird damage will result in the lowest yield. For the second and third sowing dates, the damage rate decreases as other food sources become available for birds. Table 2 illustrates this point. The highest and lower damage rates were respectively faced in the sowing dates of 5 May and 19 June. In 2008, drought led to increased damage rates because the increase in food availability for birds was less than in 2007, which was wetter. Although there was not much overall difference in damage rate between cultivars, actual rates were: Alstar 92%, Euroflor 89% and KSC43/128, 90% (Table 3).

Compound statistical analysis

The results of the compound analysis of the data indicated very significant differences between the annual data, sowing dates, and cultivars from the viewpoint of their seed yields, protected yields, and damage rates (p<0.01, Table 4). The interaction between year and cultivar was significant with protected yield and damage rate, indicating the different reaction of the cultivars in two years. No interaction was observed between sowing date and cultivar, referring to the equality of the reaction modes of the cultivars to the sowing dates in relation to the measured traits. The means of the data related to the different sowing dates indicated reduction of seed yield in parallel to the postponement in sowing dates, so that the two unprotected early sowing dates produced the highest seed yields by far of the other two sowing dates (Table 5). The lowest and highest lowest unprotected yields were obtained from the first and second sowing dates respectively. These findings confirm that the highest bird damage rates occurred for the first sowing date (of unprotected crops) and were related to the limited alternative food sources available for birds. The highest damage rate of unprotected crops was 86% for the first sowing date, significantly different from the rates experienced for any other single statistical group. Significant differences were found between seed yields of the cultivars. The hybrid KSC43/128, yielding 2,732 kg/ha was best-performing cultivar, whether protected or not (Table 6).

Table 1. The average of squares of the variance (SoV) sources of yield and damage rate in 2007 and 2008.

Year	SoV	Degree of freedom (df)	Mean square		
			Damage	Protected yield	Unprotected yield
2007	Replication	3	106.35**	229143.5**	14072.52
	A (Sowing dates)	3	434.1**	2030958**	388758.4**
	Error a	9	19.34	6027.3	9362.558
	B (Varieties)	2	950.93**	625416.4**	1168002**
	A*B	6	55.23*	9654.16	15701.91
	Error b	24	18.33	9273.56	9870.56
2008	Replication	3	112549+	2427.19	0.57
	A (Sampling dates)	3	949438.85**	85594.41**	282.72**
	Error a	9	17243.67	795.48	2.13
	B (Varieties)	2	455620.65**	29372.15**	29372.15**
	A*B	6	29972.90	726.87	1.34
	Error b	24	42395.89	1662.33	3.70

Table 2. Mean comparison of measured factors in different sampling dates in 2007 and 2008.

Year	Sowing date	Protected yield	Rank	Unprotected yield	Rank	Damage	Rank
2007	05 May 2007	3248.7	A	744	C	76.0	B
	20 May 2007	3123.1	B	1113.91	A	62.6	B
	04 June 2007	2712.5	C	942	B	64.1	B
	19 June 2007	2344.5	D	737.8	C	66.3	A
2008	05 May 2008	2564.17	A	101.33	C	96.13	A
	20 May 2008	2525.17	A	190.25	B	92.57	B
	04 June 2008	2247.42	B	258.67	A	88.44	C
	19 June 2008	1958.83	C	292.67	A	84.98	D

Table 3. Mean comparison of measured factors in different sampling dates for three varieties in 2007 and 2008.

Year	Variety	Protected yield	Rank	Unprotected yield	Rank	Damage	Rank
2007	**Allstar**	2629.0	B	636.75	C	75.1	a
	Euroflor	2965.3	A	844	B	66.8	b
	KSC43/128	2977.3	A	1172.5	A	59.7	c
2008	**Allstar**	2149.81	C	161.313	B	92.08	a
	Euroflor	2335.13	B	233.375	A	89.46	b
	KSC43/128	2486.75	A	237.500	A	90.04	b

Table 4. The averages of the squares of the variance (SoV) sources for the measured agronomical characteristics.

SoV	Degree of freedom (df)	Yield of seed	Unprotected yield	Damage
Year	1	6825600.04**	12607751.04**	13027.72**
Block/Year	1	170846.24**	37744.32**	53.46**
Sampling dates	1	2873425.02**	244174.72**	563.44**
Sampling dates*Year	6	106971.73*	230146.37**	153.37**
Error a	6	11635.48	8810.94	10.74
Varieties	6	1024518.13**	775795.71**	621.40**
Year* Varieties	3	56518.95	427237.94**	359.76**
Sampling dates*Varieties	3	26343.79	17001.07	22.67
Sampling dates*Varieties*Year	3	13283.27	22832.9*	33.89*
Error b	3	25834.73	7562.17	11.02

Table 5. The comparison of mean yield between protected and unprotected plots and bird damage rate in different sowing dates combined for 2007 and 2008.

Sowing date	Yield of seed	Rank	Unprotected yield	Rank	Damage	Rank
1	2906.42	A	446.83	D	86.05	A
2	2824.13	a	680.08	A	77.58	B
3	2479.96	b	621.17	B	76.27	B
4	2151.67	c	544.42	C	75.63	B

Table 6. The comparison of means yield between protected and unprotected plots and bird damage rate in three cultivars combined for 2007 and 2008.

Hybrid	Yield of seed	Rank	Unprotected yield	Rank	Damage	Rank
Allstar	2389.40625	c	404.40625	C	83.61	a
Euroflor	2650.1875	b	603.6875	B	78.14	b
KSC43/128	2732.03125	a	711.28125	A	74.89	c

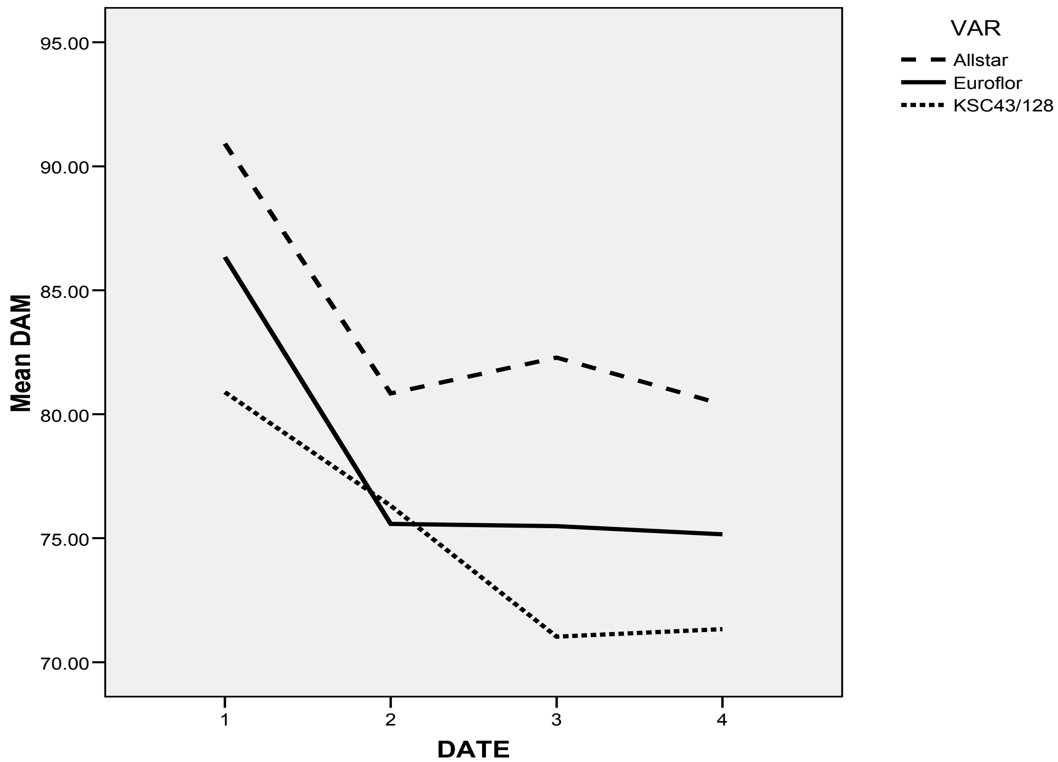

Figure 1. The comparative mean damage rate (%) of different cultivars combined for 2007 and 2008.

DISCUSSION

The hybrid KSC43/128 appears more resistant to bird damage than the other hybrids tested (Fig. 1), because it produces larger seeds. The highest damage rate was observed for the hybrid Alstar, at 84%. The mean seed yields of four sowing dates have illustrated the reduction seed yield associated with sowing date postponement in both years for protected plots (Appendix I). Appendix I also indicates that the seed yield in the first year was higher than that in the second year. With the shift in sowing date, the rate of yield reduction in the first sowing dates of the first year was higher than the same sowing date of the second year. However, the trends of changes of yield reduction in the second, third and fourth dates were similar in both years. The damage rate in the second year was more than that in the first year (Fig. 1, Table 2) because of the drought-induced decreased availability in 2008 of alternative food sources for the birds. The trend of damage rate reduction was more regular in the first year than in the second year. All the three cultivars had the least seed yield from the first sowing dates. The highest unprotected seed yield of Alstar and Euroflor resulted from the second sowing date, while that of the hybrid KSC43/128 came from the third sowing date (Appendix I). The least rate of damage was found with the fourth sowing date.

In other studies, there similar were significant differences in the mean percent bird damage among planting dates and among genotypes at Fargo, but only among genotypes at Valley City location (Samanci 1987). Similar results were obtained by Damavandi *et al.* (undated) where among four sowing dates (24 April, 7 May, 21 May and 2 June 2002) of Record and Zaria sunflower cultivars, the maximum (4,237 kg/ha) and minimum (3,490 kg/ha) grain yield was obtained from the second and fourth sowing dates, respectively (Damavandi *et al.*, undated). A study in Turkey (Killi *et al.* 2004) on two sunflower cultivars, Pioneer 64A52 (hybrid-oilseed sunflower) and Inegöl (confection sunflower) for 8 different planting dates (the first on 25th March, the others following at about 10-day intervals) indicated that planting date was important with respect to bird damage rates to sunflowers. Killi *et al.* 2004 found that the 5 and 15 April planting dates resulted in the lowest bird damage to the Inegöl (confection) sunflower variety. On the other hand, delaying planting until 5 June resulted in a significant increase in bird damage to P-64A52. Oilseed sunflower cultivars were highly preferred by birds to confection sunflowers (Killi *et al.* 2004).

Regarding physiological views, Jessop (1977) found the delay in sowing date from July to February (in the austral growing cycle of the southern hemisphere; July in Australia is mid-winter and February is mid-summer) shortened the total growing period and also the time between sowing and flower initiation, the reason for lower seed yield for later sowing dates in this study (Appendix I). Like Cummings (1978), Esmail (no date) found that more than 60% of crop damage occurred within the first 18 days after anthesis when the seeds were in the doughy stage of development (supported by Khaleghizadeh *et al.* 2005). When sunflower crops were sown at Ludhiana, Indian Punjab, from November to March, the January sowing was the most suitable in terms of yield and reduced damage exposure to the birds, as well as giving the best emergence and percentage of seed set, together with early maturity and low damage at maturity (Mahli 2000). Early damage occurs first near the margins but later the whole crop is damaged, suggesting early harvesting (Fleming *et al.* 2002) is prudent.

Overall, with the change in sunflower sowing date, the maximum damage rate was observed in the period between the first and second sowing dates. Maximum damage occurred for the first sowing date – see the comparison for the other sowing dates at Fig. 1. Therefore, it is suggested that when the area of sunflower cultivars in research trials is small, it should be fully protected, because the whole seed crop is crucial for future sunflower research. The high bird damage rates detailed in this study infer that local famers have decided to avoid oilseed cultivars in preference to the prevalent and widespread confection cultivars, the latter being much more likely to produce a good seed crop reliably. It is also suggested that it would be prudent to use resistant cultivars such as KSC43/128 for future research projects.

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Appendix 1. Yield (g of dry seeds/plot) of three cultivars of Sunflower planted in four sowing dates in Iran. P = protected, U = unprotected.

	Alstar		Euroflor		KSC43/128		Total	
2007/2008	**P**	**U**	**P**	**U**	**P**	**U**	**P**	**U**
05 May 07	2,982.0	472.7	3,372.5	767.5	3,391.5	1,136.7	3,248.7	792.3
20 May 07	2,873.2	939.5	3,192.2	1,295.0	3,303.7	1,275.2	3,123.1	1,169.9
04 Jun 07	2,513.7	632.5	2,816.2	1,005.2	2,807.5	1,313.2	2,712.5	983.7
19 Jun 07	2,147.0	545.2	2,480.0	828.2	2,406.5	1,015.0	2,344.5	796.2
2007 Totals	**2,629**	**647.5**	**2,965.25**	**974**	**2,977.31**	**1,185.06**	**2857.19**	**935.52**
05 May 08	2,342.5	54.0	2,683.5	123.0	2,666.5	127.0	2,564.2	101.3
20 May 08	2,311.2	128.2	2,527.2	205.5	2,737.0	237.0	2,525.2	190.2
04 Jun 08	2,061.5	207.2	2,200.7	292.5	2,480.0	276.2	2,247.4	258.7
19 Jun 08	1,884.0	255.7	1,929.0	312.5	2,063.5	309.7	1,958.8	292.7
2008 Totals	**2,149.81**	**161.31**	**2,335.12**	**233.37**	**2,486.75**	**237.5**	**2,323.90**	**210.73**