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Developing Economic Injury Levels for Thrips (*Frankliniella occidentalis*) in Idaho Alfalfa Under Controlled Pest Populations

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Abstract. Thrips are a new pest of alfalfa in Eastern Idaho. University of Idaho Extension Educators studied the yield losses associated with this pest in a controlled greenhouse experiment. This data has been used to calculate the economic injury level (EIL) of thrips in alfalfa. The EIL represents the level of insect infestation at which control measures will begin to be economically viable. We calculate that for the 2021 growing season conditions the EIL was approximately 20 thrips per six stems. We also calculated EIL curves that growers and consultants can use as spray costs and hay values change.

Thrips (*Frankliniella occidentalis*; see Figure 1) have not been considered a major insect pest of alfalfa in Idaho. They are not listed as a pest of alfalfa in the *Pacific Northwest Pest Management Handbook* (Hollingsworth, 2019), nor are they listed as an alfalfa pest in the *Alfalfa Management Guide* (Undersander et al., 2011). University of Idaho Extension Educators, however, have found that thrips are a new and emerging pest of southern Idaho alfalfa crops. Major infestations occur near rabbitbrush-covered rangelands. Rabbitbrush is an alternative host for thrips and may be a contributing factor for outbreaks of this pest. Growers attending University of Idaho Commodity Schools in southern Idaho expressed a concern that thrips were causing economic damage to their crops (see Figure 2). Damage occurred as leaf rolling and scaring due to feeding. They had limited information regarding when control measures would become economically viable, which made it difficult to correctly time pesticide applications and follow integrated pest management practices.

Area specialists and Extension educators surveyed for thrips in 2018 and found large numbers of them. Thrips populations were found to be low during the initial two cuttings but increased at the final third cutting. In 2019, the University of Idaho forage team developed a thrips-scouting protocol to ensure that all sampling could be replicated in future studies. This protocol was based on randomly collecting six alfalfa stems and researching and visually evaluating the damage

Figure 1. Western flower thrips (*Frankliniella occidentalis*).

Figure 2. Damage to alfalfa (*Medicago sativa*) by thrips.

from thrips feeding on crops. This research continued in 2020, with a field trial that evaluated the effect of this damage on alfalfa yield (Findlay et al., 2020). A preliminary economic injury level (EIL) was calculated through this initial research. An *EIL* is defined as the smallest number of insects that will cause a yield loss equal to the insect management costs (Hunt et al., 2009). It was recommended that further research be conducted using controlled thrips populations to calculate a more precise EIL. Economic thresholds were developed based on previous EIL research and have not been calculated at this point for thrips in alfalfa. An *economic threshold* is defined as the density of a pest at which control measures should be implemented to prevent the pest population from reaching the EIL (Hunt et al., 2009). This paper reports the results of a portion of our overall research efforts. Filed research on this pest was conducted prior to this greenhouse study (Findlay et al., 2020).

In 2021, University of Idaho Extension educators designed a controlled thrips population experiment for accurate population counts and yield assessment. This experiment was completed in a controlled greenhouse with various initial pest populations. Experimental results from this controlled study were used to calculate accurate EILs for thrips in alfalfa crops.

This information will assist Extension educators, crop consultants, and growers in making more informed pest control decisions. It will also give Extension educators and researchers knowledge and information that can be used to develop economic injury calculations for other emerging pests in their own regions.

MATERIALS AND METHODS

A randomized complete block design was used to evaluate four levels of initial thrips infestation on alfalfa. The block levels consisted of four replications of the experiment placed east to west in the same greenhouse. The treatment levels included a control with no introduced thrips and three levels with initial thrips populations of 50, 100, and 200, respectively. The experiment included three replications of these treatments. Plots measured 2 ft. by 2 ft. A ClimaPod greenhouse with four automatic gas-driven exhaust louvers and two additional solar-powered ventilation fans was used to maintain the inside environment. Total greenhouse dimensions were 30 ft. by 20 ft. Thrips exclusion netting was used to enclose each plot and protect them from the introduction of nondesign pests and covered the plots at all times. The netting was composed of transparent high-tensile-strength polyethylene monofilaments and purchased from BioQuip. The thread size was 0.24 mm, and the hole opening size was 0.0105 in. by 0.0322 in. (192 microns). The netting was specifically designed to exclude thrips but allow for adequate light and air penetration. Peak light intensity was measured at 148.09 w/m^2 at midday outside the netting and was 146.48 w/m^2 under the netting. Alfalfa was clear seeded to equal a rate of 15 lb. of seed per acre in large 5-gal. containers. The depth of the containers was 2 ft. The plots were fertilized according to University of Idaho recommendations (Stark et al., 2002). Following germination and crop emergence, plots were thinned to a density of 25 stems per square foot to simulate a typical stand of alfalfa (Undersander et al., 2011).

On April 19, 2021, western flower thrips were collected from southern Idaho alfalfa fields by using an aspirator that placed insects into glass vials. These vials were placed in a Styrofoam insulator and transported to the lab within an hour of capture. Thrips were identified in the lab by university entomologists specializing in thrips research. The vials were loaded with 0, 50, 100, or 200 thrips. Three sets of vials were prepared for the experiment design replication requirement. These vials were placed into the enclosures through sewn entry ports and uncapped inside the netting to release the test thrips population. Enclosures were irrigated and maintained throughout the entire growing season. All enclosures were harvested on July 27, 2021. The entire plot was harvested with hand clippers and dried in University of Idaho crop dryers. Crop damage was evaluated visually, and near-infrared analysis was used to determine protein and palatability levels. These two parameters were not used in calculating an EIL. Yield and thrips population counts were taken at harvest. These two parameters were used to calculate the EIL for this experiment. Forage yield was calculated on a 15% moisture basis. Thrips population counts were based on the total number found on 6 alfalfa stems cut to a 6-inch length. This was done to follow scouting methods used in previous years. Yield and crop damage data were used to calculate a precise EIL.

RESULTS AND DISCUSSION

Alfalfa yields were not reduced at thrips insect introduction levels of 0, 50, and 100 thrips per plot (cage). When 200 thrips were initially introduced, a significant alfalfa yield reduction was measured (see Figure 3). Mean separation was conducted with a protected least significant difference test. No significant blocking effect was observed. Figure 3 shows the relationship of initial thrips levels to final yield. These data were not used in the EIL calculation, which was based on final thrips counts and to what level the yield was reduced by these counts.

Final thrips populations were counted just prior to harvest by selecting six random stems and counting all thrips on the group of stems. Yield losses for plots containing thrips were calculated by comparing yields to the control plot that contained no thrips. Regression analysis gave the relationship of thrips count to yield loss by way of the following equation: yield loss (tons/acre) = 0.0 + 0.0115 × number of thrips (see Figure 4). Starting with a base yield loss of zero, every additional thrip counted increased the yield loss by 0.0115 tons/acre. Example: If the thrips count was 50, yield loss = 0.0 + 0.0115 (50) = 0.575 tons/acre. The gap in data points

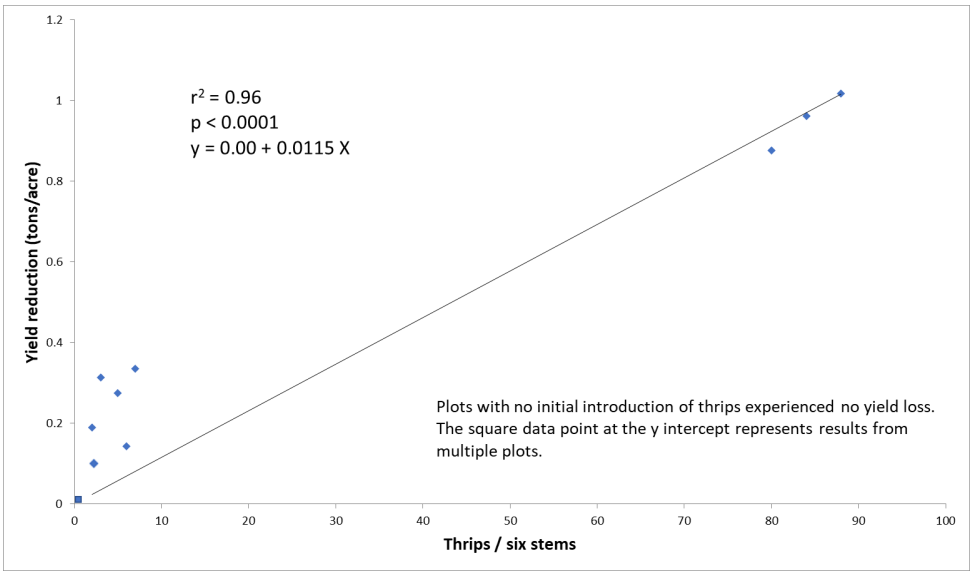

Figure 3. Thrips' feeding effect on alfalfa yield

can be attributed to rapid thrips population increases and to only the highest level of initial thrips causing yield reductions. Thrips populations were either low or quite high upon evaluation. This greenhouse study was supplemental to previous field studies (Findlay et al., 2020) and had fewer data points than the previous studies due to the limited space provided in greenhouse studies compared to field trials.

EIL calculations were based on the equation EIL = $C/(V \times DI \times K)$, where C equals the pest management costs, V equals the market value of the hay, DI equals the yield loss per insect, and K equals the pest control percentage (Damos, 2014; Hunt et al., 2009; Pedigo et al., 1986). Pest management costs were obtained from the eastern Idaho alfalfa hay production 2019 costs and returns estimates (Eborn et al., 2019). Market value was based on the University of Idaho Economic Outlook conference proceedings (Hines & Findlay, 2021). Yield losses and pest control percentages were calculated by regression analysis from this controlled pest population study.

EILs are not static; they will change as values and prices move with markets. We calculated these changes if spray costs and hay values were to increase (see Figure 5).

Thrips feeding on alfalfa crops are associated with significant economic costs. Yield and revenue losses increase as thrips populations increase. The effect of thrips feeding on alfalfa crops was most significant when net returns were calculated (see Table 1). These net return values were calculated assuming that hay values were $160 per ton and spray costs were $25 per acre. As stated previously, these values were taken from 2019 costs and returns estimates. For comparison purposes, this table is based on implementing insect control measures at all thrips population levels.

This research is preliminary, and further research will be needed to fix a definite EIL for thrips in alfalfa crops. This

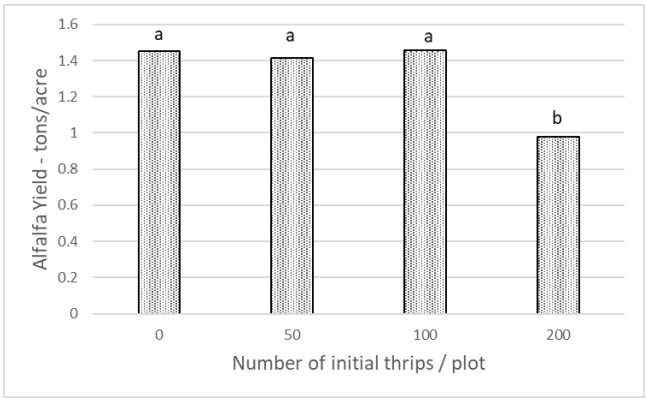

Figure 4. Thrips' effect on alfalfa yield

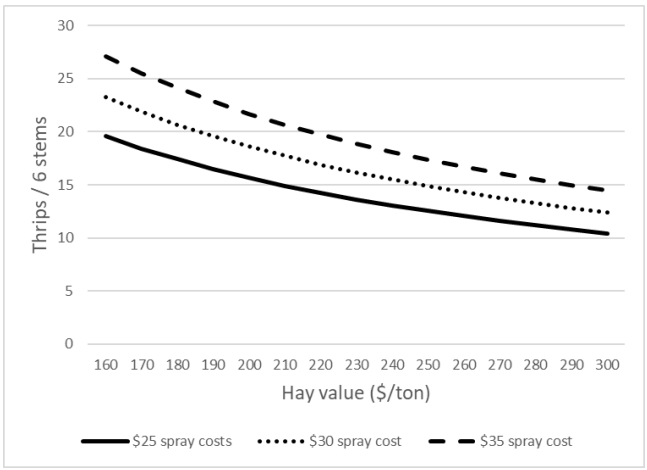

Figure 5. Economic injury level for thrips on alfalfa if costs and hay value change

Table 1. Yield and Economic Parameters of Thrips Damage to Alfalfa

Thrips/6 stems	Yield loss (tons/acre)	Yield loss ($/acre)	Yield with control (tons/acre)	Net return per acre with control
0	0.00	$0.00	1.60	$231.00
1	0.01	$1.84	1.59	$229.71
2	0.02	$3.69	1.58	$228.42
5	0.06	$9.22	1.56	$224.54
10	0.12	$18.45	1.52	$218.09
12	0.14	$22.14	1.50	$215.50
15	0.17	$27.67	1.48	$211.63
17	0.20	$31.36	1.46	$211.56
20	0.23	$36.90	1.44	$209.05
25	0.29	$46.12	1.40	$206.00
50	0.58	$92.24	1.20	$205.17
75	0.86	$138.37	0.99	$198.71
100	1.15	$184.49	0.79	$166.43
150	1.73	$276.73	0.39	$134.14

research team is currently supplementing the above research with a study aimed at determining the effect thrips feeding has on alfalfa quality. We will focus on protein content and palatability, as these quality factors will change the value of the alfalfa and modify the EIL. This continued research will assist in fixing a more precise EIL and provide a pathway for the calculation of an economic threshold in the future.

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