THE EFFECTS OF INSECTICIDE TREATMENTS ON SUGARCANE APHID, YIELD AND FEED QUALITY OF FORAGE SORGHUM IN CALIFORNIA, 2018

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Introduction

During 2018, we conducted a trial in Shafter, CA, to evaluate the impact of insecticides on the density of Sugarcane Aphid (SCA) (*Melanaphis sacchari* [Zehntner]) in forage sorghum (*Sorghum bicolor* (L.) Monench 'NK 300') and the related impacts on yield and forage feed quality. The field site was planted on 16 Jun to the sorghum cultivar NK 300 at 100,000 seeds/acre to moisture on 30" beds. Fertilizer, irrigation, and weed management programs were executed according to industry standard practices for the region. Plots were organized into a randomized complete block design with four replications. On 9 Aug SCA were collected from commercial fields in Tulare Co., CA, transported to the research plot, and distributed onto the sorghum leaves. SCA populations were allowed to establish in the field and increase naturally for approximately two weeks before foliar treatments were applied. Foliar insecticide applications (Table 1) were made at the initiation of sorghum heading on 22 Aug using a high clearance spray rig with a 4-row boom using drop nozzles. Aphid populations were monitored twice a week through harvest by counting the number of aphids on 10 to 20 mid-canopy leaves per plot. The number of cumulative aphid-days for each plot was calculated by multiplying the number of SCA at 5 DAT by 5 days, then for the other evaluation dates calculating the average SCA per leaf for the current and previous sample date and multiplying by the number of days between evaluations, and then calculating the sum of the aphid-days from all evaluation dates.

The middle two rows of each plot were harvested on 23 Oct, plot weights and lengths were measured to estimate yield (Table 2), and sub-samples for calculating percent dry matter and determining forage feed quality were obtained. Dried sub-samples were sent to a feed quality analytical lab for wet chemistry analyses of several critical factors (Table 3).

Results and discussion

Sugarcane Aphid Control Efficacy

There were no significant differences in SCA density prior to treatment. After treatment the lowest SCA densities were in plots treated with flupyradifurone (Sivanto Prime, Sivanto HL, or Dimethoate + Sivanto HL) on all evaluation dates (Table 1 & Figure 1). Afidopyropen (Sefina) at 6 fl oz aphid population was significantly lower than the untreated check at 5, 14, 48, and 54 DAT. The higher rate of Sefina (12 fl oz) and sulfoxaflor (Transform WG) were significantly lower than the untreated check at 5, 14, and 41 DAT. Dimethoate + Sivanto HL followed the same pattern as the other Sivanto treatments in the trial, whereas SCA densities in plots treated exclusively with Dimethoate were the same as, or in many cases higher than, the untreated check. The lowest SCA cumulative aphid-days were in plots treated with Sivanto. Transform and Sefina also reduced SCA density and were statistically equivalent.

Insecticide Treatment and Aphid Population Impacts on Yield

Insecticide treatments did not have a significant effect on corrected dry matter yield (p = 0.476) or percent dry matter of harvested material (p = 0.914) (Table 2 & Figures 2-3). The untreated check did have the lowest average yield (26.4 tons/acre). The dimethoate alone yielded the next lowest at 30.7 tons/acre. The remaining treatments all similarly yielded relatively higher within a narrow range from 31.8 tons/acre (Transform WG @ 2 oz/acre) to 35.2 tons/acre (Sivanto HL @ 3.5 fl oz/acre). Yield protection relative to the untreated control ranged from 4.3 to 8.8 tons/acre at 30% dry matter. Percent dry matter at harvest between treatments was similar, ranging from 28.6% to 30.1%, with no an apparent effect of treatment.

Impacts of aphid population, measured as cumulative aphid-days, on yield and dry matter percent at harvest were estimated by performing correlation and linear regression analyses. Aphid-days significantly and indirectly correlated with yield (R = 0.377, R^2 = 0.142, p = 0.034) (Figure 4). Though correlation was low, it is estimated that for every cumulative 1,000 aphid-days, yield was decreased by approximately 1.8 tons/acre. Correlation was even lower between aphid-days and harvested percent dry matter and a linear regression was not statistically significant (R = 0.115, R^2 = 0.013, p = 0.528) (data not shown).

Insecticide Treatment and Aphid Population Impacts on Forage Feed Quality

Individual treatments did not have statistically significant effects on any of the feed quality parameters tested in this trial (Table 3). Cumulative aphid-days, however, did have significant relationships with several feed quality parameters (Figure 4). Crude protein and ash contents were both directly related to cumulative aphid-days (R = 0.434, R^2 = 0.188, p = 0.013;

and R = 0.564, R^2 = 0.318, p = 0.001, respectively). For every 1,000 cumulative aphid-days, it was predicted that crude protein and ash contents would increase by 0.4 and 0.5% of dry matter, respectively. Non-fibrous carbohydrates (NFC) were indirectly related to cumulative aphid days (R = 0.363, R^2 = 0.132, p = 0.041). It was predicted that for every 1,000 cumulative aphid-days NFC would decrease by 1.5% of dry matter.

While correlations were statistically significant yet not relatively strong, it's clear that in this trial the most determinant factor driving forage feed quality was relative control of aphids rather than particular insecticides. If farmers opt to only use foliar application of insecticide to control SCA, focus should be primarily on optimal control of the bug. Crude protein increase in this case should not necessarily be considered a benefit since in a proximal analysis anything that increases is at the expense of something else decreasing. Since ash content (non-nutritious mass of the feed) also increased with more aphid pressure, it's safe to assume that crude protein increased at the expense of carbohydrates as evidenced by the decrease in NFC. Nutritionists should be able to adjust for the quality profiles of individual feed stuffs in the total mixed ration, but it's still best to start with predictable, high quality feed values to avoid heterogeneity in feeding outcomes as well as the need to supplement with more expensive feeds or additives.

Summary

Aphid pressures achieved in the 2018 season were low throughout the season. Treatments including Sivanto exhibited high control of SCA throughout the entire evaluation period (up to 54 DAT), especially compared to Dimethoate alone and the untreated check. Sefina and Transform treatments showed efficacy similar to Sivanto treatments through at least 28 DAT. Although SCA counts in Sefina and Transform plots were nominally higher throughout the season, aphid pressure remained below the treatment threshold season-long with the exception of

Transform reaching the treatment threshold of 50 aphids/leaf at 48 DAT. The real segregation between treatment efficacies on SCA control was evident in the calculation of cumulative aphid-days. Sefina and Transform treatments were significantly higher in cumulative aphid-days than the Sivanto treatments but significantly lower than the Dimethoate treatment. Transform was statistically similar in cumulative aphid-days to the untreated check, yet only half the aphid-days were accumulated in the Transform plots relative to the untreated check.

In this trial, individual insecticide treatments did not have significant effects on yield or percent dry matter at harvest, though average yield protection was observed in all treatments relative to the untreated check. The determinant factor that explained yield loss was cumulative aphid days. Treatments with more aphid-days had significantly less yield. Therefore, insecticide choice is only as important as pest scouting and decisive adherence to treatment threshold guidelines to ensure SCA population throughout the season remains low.

Forage feed quality characteristics were not impacted directly by individual insecticide treatments. However, crude protein, ash content, and NFC were significantly affected by cumulative aphid days. Crude protein and ash increased with increasing aphid-days, whereas NFC decreased with increasing aphid-days. PCA's and nutritionists should consider the economic implications of degraded forage quality as a result of poor SCA control. This decision is likely dynamic since it will involve the cost of production of the sorghum, the feeding goals or animals destined to consume the sorghum, and the capacity of the individual dairy operation to adjust the TMR to adjust for potentially poor feed quality factors in the sorghum fraction. Many growers in the San Joaquin Valley of CA will increase their sorghum acreage when irrigation water availability is low or soil quality is too marginal for high corn production. Replacement of corn with forage sorghum when SCA can significantly, negatively impact forage feed quality is a critical issue and under these conditions probably poses the most important economic consideration for dairy operators, forage growers, and animal nutritionists when they are coordinating plans to produce quality feed for dairy animals' health and productivity.

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Tables and Figures

Table 1. Foliar insecticide treatment effect on Sugarcane Aphid population in forage sorghum

Treatment/formulation	Rate form prod/acre[1]	Mean SCA per leaf											
		PRE	5DAT	9DAT	14DAT	19DAT	22DAT	28DAT	34DAT	41DAT	48DAT	54DAT	Aphid-Days
Check	-	7.4a	16.1c	36.0bc	53.1cd	15.0bc	7.0a	13.3a	51.1c	58.1e	79.1d	49.2de	2113cd
Sivanto Prime	7.0 fl oz	15.6a	0.9a	2.2a	1.4a	1.3a	0.3a	1.0a	0.1a	1.1a	4.5ab	4.5a	87a
Sivanto HL	3.5 fl oz	11.9a	2.1ab	5.1a	4.0ab	0.7a	0.6a	0.2a	0.4a	1.3a	0.8a	4.0a	92a
Transform WG	2.0 oz	12.4a	3.8ab	3.1a	19.9bc	7.6abc	5.8a	14.3a	30.1bc	26.2cd	75.0cd	44.9e	1283bc
Sefina	6.0 fl oz	10.0a	6.5b	12.5ab	13.2ab	26.2cd	19.6a	36.4a	22.0bc	28.9cde	20.3abc	17.8abc	1110b
Sefina	12.0 fl oz	9.1a	5.9ab	18.4ab	14.0ab	2.9ab	19.0a	14.5a	36.0bc	15.8bc	10.2ab	26.1cde	866b
Dimethoate	32.0 fl oz	16.3a	20.6c	66.6c	56.9d	47.0d	73.3b	119.5b	25.4bc	51.1de	28.0bcd	61.8e	2853d
Dimethoate + Sivanto HL	32.0 fl oz + 3.5 fl oz	8.9a	2.1ab	3.1a	3.3ab	0.7a	1.0a	1.3a	7.7ab	3.5ab	5.9ab	15.6ab	220a
	F	1.09	9.19	6.35	6.63	5.36	4.07	3.78	3.64	10.27	4.29	6.20	17.17
	P	0.407	<0.001	<0.001	<0.001	0.001	0.006	0.008	0.010	<0.001	0.004	0.001	<0.001

Data were square root transformed to meet assumptions of ANOVA; actual means are displayed. Values in a column followed by the same letter are not significantly different; *P* =0.05, FPLSD.

[1] All treatments included 8 fl oz/ac of R-11 as a surfactant.

Table 2. Sugarcane aphid insecticide treatment effect on forage sorghum yield and percent harvested dry matter

Treatment	Rate form prod/acre	30% DM Yield ± SD (tons/acre)	Harvested % DM ± SD
Check	-	26.4 ± 2.2	29.9 ± 1.2
Sivanto Prime	7.0 fl oz	32.4 ± 6.9	28.6 ± 1.5
Sivanto HL	3.5 fl oz	35.2 ± 3.9	30.0 ± 1.1
Transform WG	2.0 oz	31.8 ± 4.8	29.8 ± 1.9
Sefina	6.0 fl oz	32.7 ± 4.3	29.5 ± 2.2
Sefina	12.0 fl oz	32.3 ± 3.2	30.0 ± 2.2
Dimethoate	32.0 fl oz	30.7 ± 9.3	29.2 ± 1.8
Dimethoate + Sivanto HL	32.0 fl oz + 3.5 fl oz	33.4 ± 3.8	30.1 ± 1.2
	F	0.968	0.364
	P	0.476	0.914

Table 3. Proximal analyses of select forage sorghum feed quality parameters as affected by insecticide treatment expressed as mean percent of sample dry matter

Treatment	Rate form prod/acre	CP	Ash	ADF	aNDF	Lignin	Starch	Fat	tNDFD 30[1]	tNDFD 30 om[1]	uNDF 30[1]	NFC
Check	-	10.7	10.5	27.9	39.8	5.9	27.1	2.2	43.6	46.7	22.6	37.4
Sivanto Prime	7.0 fl oz	10.1	9.7	28.4	42.9	6.1	23.4	2.2	44.5	49.2	23.7	36.4
Sivanto HL	3.5 fl oz	9.8	9.8	27.7	41.1	6.2	28.1	2.2	45.6	50.2	22.3	38.4
Transform WG	2.0 fl oz	10.0	9.5	26.9	40.3	5.7	29.5	2.5	43.4	47.2	22.7	39.0
Sefina	6.0 fl oz	10.0	9.8	26.9	40.2	6.2	28.4	2.6	38.3	43.2	24.6	38.6
Sefina	12.0 fl oz	9.9	9.5	27.2	39.7	5.8	27.0	2.5	45.6	50.6	21.5	39.7
Dimethoate	24.0 fl oz	10.3	11.2	28.0	41.9	5.9	26.5	2.3	43.5	45.7	23.7	35.4
Dimethoate + Sivanto HL	24.0 + 1.75 fl oz	10.0	9.7	26.5	38.4	6.3	29.6	2.8	38.7	42.6	23.4	40.4
	F	0.960	2.113	0.229	0.513	0.638	0.638	1.965	1.007	1.218	1.292	0.553
	P	0.484	0.081	0.974	0.816	0.720	0.720	0.103	0.451	0.331	0.302	0.786

[1] Percent of ND

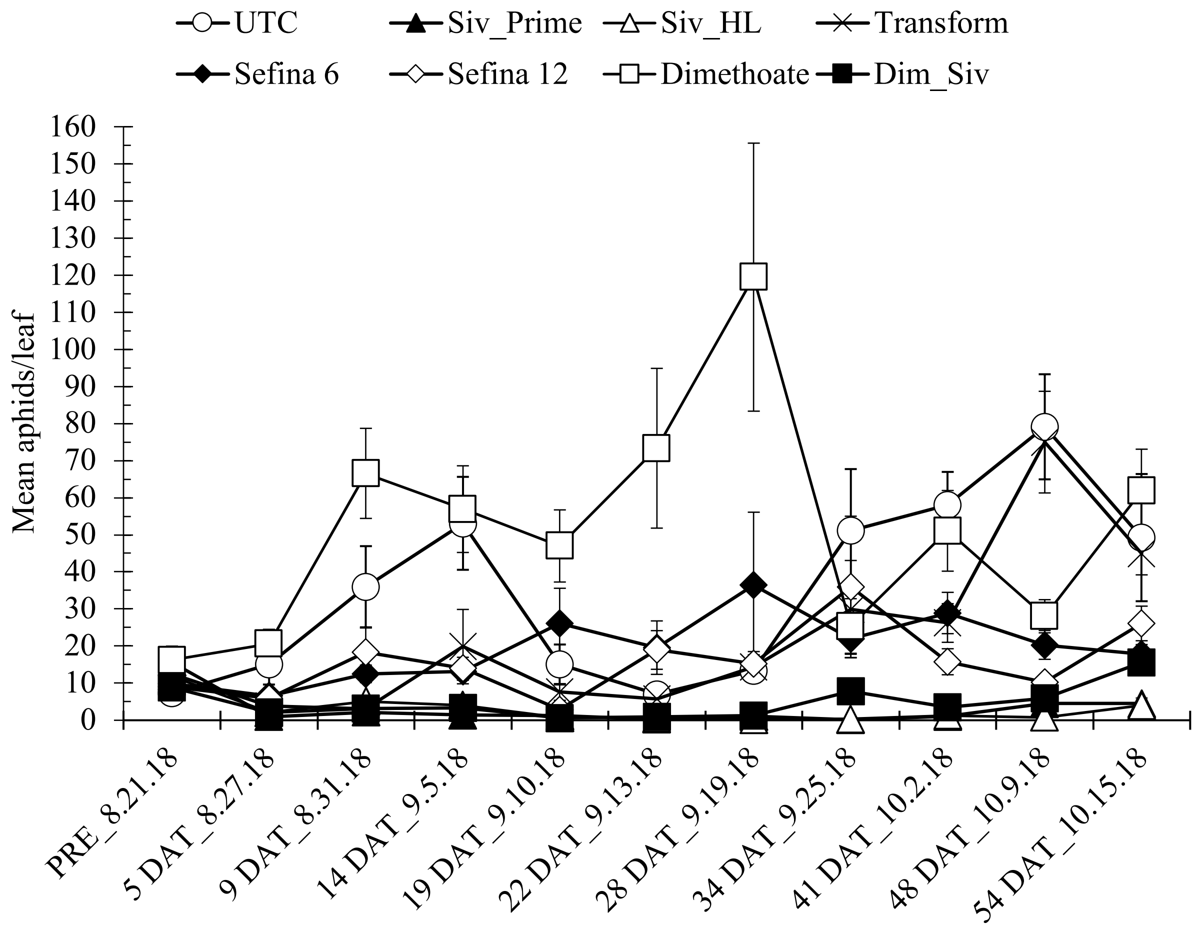

Figure 1. Insecticide treatment effect on mean Sugarcane Aphids/leaf over the course of 54 days after treatment. Bars represent one standard error of the mean.

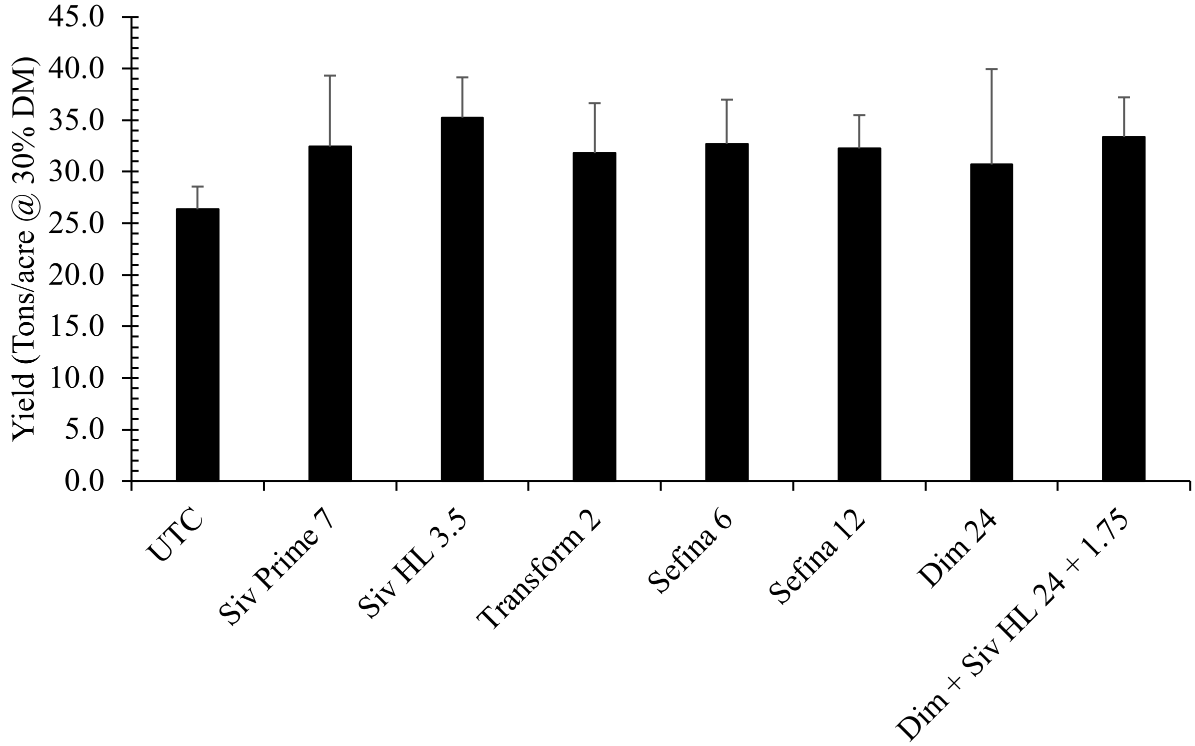

Figure 2. Sugarcane Aphid insecticide treatment effect on forage sorghum yield. Bars represent one standard deviation.

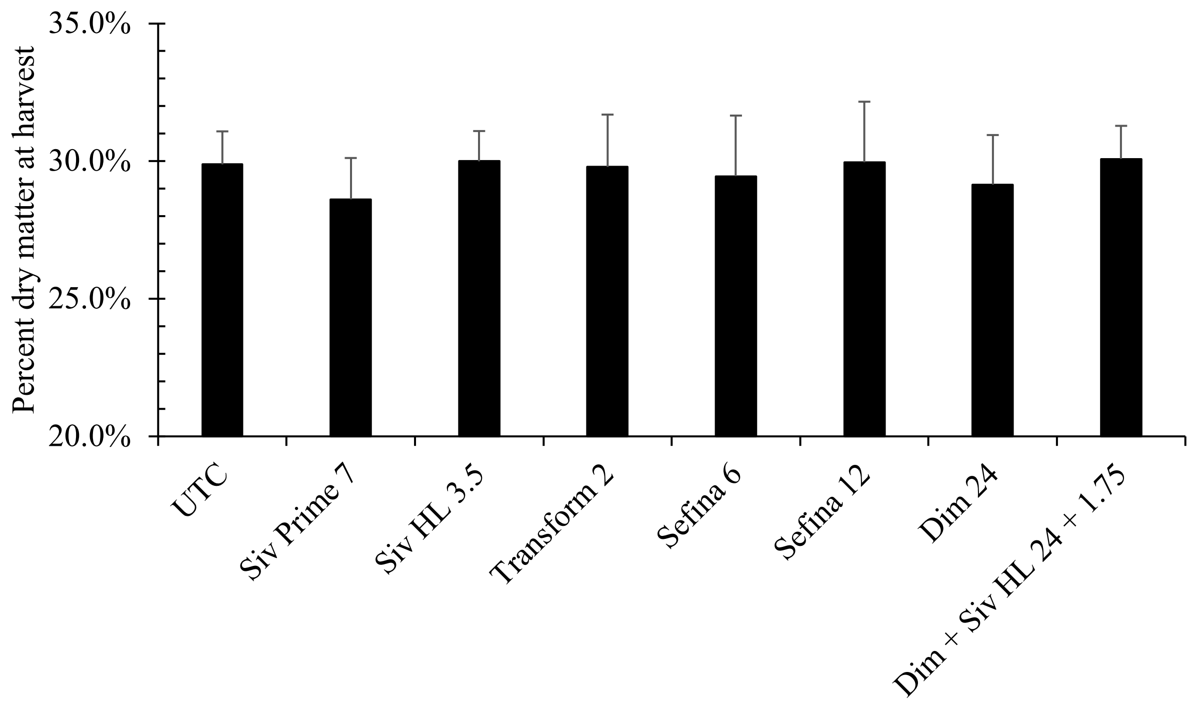

Figure 3. Sugarcane Aphid insecticide treatment effect on harvested percent dry matter of forage sorghum. Bars represent one standard deviation.

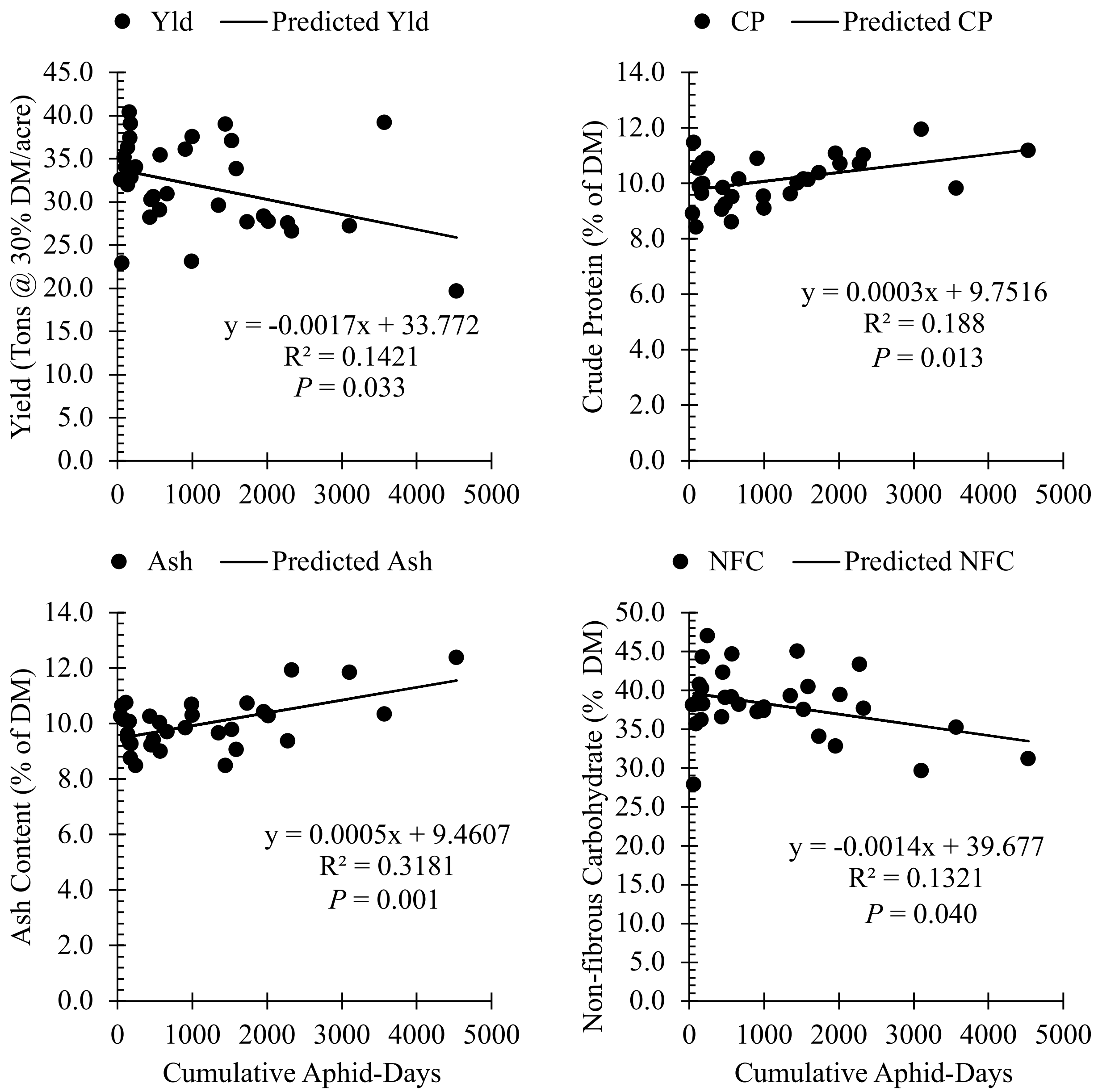

Figure 4. Linear regressions of cumulative aphid-days prediction of measured crop yield (top left), crude protein content (top right), ash content (bottom left), and non-fibrous carbohydrate content (bottom right).