THE EFFECT OF VEGETABLE OIL CARRIERS AND ADJUVANTS ON HERBICIDE EFFICACY

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Introduction

Historically, oils have played a significant role in weed control. Phytotoxic oils, derived from crude oil or distillates from petroleum or coal tar, were utilized extensively as both selective and nonselective herbicides. Oils have been, and con tinue to be, used as solvents in herbicide formulations, as adjuvants to enhance herbicide efficacy and in some cases as carriers for herbicide application.

Although traditionally petroleum based oils were used there has been interest in vegetable oil adjuvants. Recently, this interest has been renewed and, with the development of low volume application technology, has extended to vegetable oil carriers. There have been conflicting reports as to the efficacy of vegetable oil carriers and adjuvants. Depending on the environment, the herbicide, the crop-weed composition and various application factors, herbicide activity has been reduced, enhanced or unaffected by vegetable oil in the spray mixture.

Most of this work has been done outside of Western Canada so there has been little emphasis on locally grown oil products. Canola oil is produced locally and if vegetable oil adjuvants and carriers are to be used in Saskatchewan it would be economically advantageous to use this product.

The objective of this project was therefore: to evaluate canola oil both as an adjuvant and as a carrier for herbicide applications. Three herbicides, sethoxydim (2-[1-(ethoxyimino)-butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one), glyphosate (N-(phosphonometthyl)glycine), and 2,4-D ((2,4-dicohlorophenoxy)acetic acid) were chosen for this work because of their extensive usage in Saskatchewan.

Method

To meet these objectives a series of field and growth room studies were run for each herbicide. Each test is outlined briefly below. Unless otherwise stated the test species were: barley (var Klages) for the glyphosate tests; canola (Tobin) for the 2,4-D tests; and barley (var Conquest) for the sethoxydim tests.

Field 1984

Two rotary atomizer nozzles, spaced 1.01 m (40") apart with disc speed 2000 RPM were used to apply the various herbicides. The herbicides were applied in either water alone, refined canola oil + the emulsifier Canplus 129 (15% by wt) or in a 6.25 % refined canola oil (+ emulsifier) water mix. In all cases the carrier volume was kept constant at 22.4 l/ha (2 gpa).

A split plot design was used with herbicide rate (0x, 1/4x, 1/2x and 1x recommended rate) as the main plot factor and the three carriers/adjuvants as the subplot factor.

Unfortunately, due to a poor crop emergence the 2,4-D test could not be run with canola. Instead the above treatments were applied to wheat (var Neepawa) with a natural stand of wild mustard. Plots were visually evaluated for both crop tolerance and weed control.

Field 1985

Canola and soybean oils were evaluated as adjuvants and low volume carriers for application of all three herbicides. The experiment was run in the field using a modified factorial design. Factors and levels tested are shown below.

FACTOR	LEVEL
adjuvant type	1. crude degummed canola oil + emulsifier (15% wt:wt) 2. crude degummed soybean oil + emulsifier (15% wt:wt)
percent adjuvant in mix	0.00, 0.50, 3.50, 6.25
Application method	1. low volume rotary atomizer (lvra): 22.4 l/ha, spraying systems discs, 1.01 m centers, disc speed 2000 rpm 2. high volume rotary atomizer (hvra): 100 l/ha, spraying systems discs, 1.01 m centers, disc speed 2000 rpm 3. high volume flat fan (hvff): 100 l/ha, 8001 nozzles, 300 kpa

ADDITIONAL TREATMENTS

1. crude degummed canola oil carrier lvra
2. crude degummed soybean oil carrier lvra
3. crude degummed canola oil carrier control lvra
4. crude degummed soybean oil carrier control lvra
5. crude degummed canola oil adjuvant control (6.25% in mix) lvra
6. untreated control

Herbicide was applied with all treatments except the controls. 2,4-D was applied at 210 g ai/ha, sethoxydim at 175 g ai/ha and glyphosate at 214 g ai/ha.

Growth Room

Plants were grown under a 16 h photoperiod with day/night temperatures 21/15 ^{o}C respectively. They were seeded nine to a pot but thinned to four shortly after emergence. Plants were fertilized with a liquid nutrient solution as required.

These tests were run to compare differences between canola oil and soybean oil when used as a carrier or as an adjuvant (6.25% vol/vol). A microsyringe was used to apply the treatments in 2 X 1 ul drops to the first leaf when plants were in the four leaf stage. The carrier/adjuvants were evaluated under both high and low humidity regimes.

Visual evaluations were made at regular intervals after treatment. Plant top growth was also harvested and both fresh weight and dry weight measured.

Results

2,4-D ester

In the 1984 field tests 2,4-D control of wild mustard was best when the chemical was applied in water alone, intermediate when applied with the canola oil carrier and worst when applied with a canola oil adjuvant. These differences were all significant at the 5% level. There was no crop injury observed with any of the treatment combinations.

In 1985 both oil carriers reduced herbicide activity however a very slight enhancement was seen with the oil adjuvants at the low application volumes. The oil adjuvants had no significant effect on activity at the high application volumes.

Humidity had no significant effect on 2,4-D activity in the growth room studies. Neither vegetable oil carrier or adjuvant had a significant effect on herbicide activity in the lab.

Glyphosate

Glyphosate applied in canola oil was significantly less phytotoxic than when applied in water alone or in the water-oil mixture in the 1984 field test. The water plus oil treatment gave intermediate control except at the high herbicide rate where differences were probably hidden by the high level of control achieved with both treatments. A general reduction in glyphosate activity was also observed in 1985 when the herbicide was applied with either oil adjuvant or carrier. Glyphosate activity was not affected by humidity in the growth room test. Activity was reduced by both oil carriers although not by the oil adjuvants.

Sethoxydim

In the 1984 field tests sethoxydim applied in oil alone gave significantly poorer barley control than when applied in water alone or in the water oil mixture (Table 1). There was no significant difference between water alone or the water oil mixture in terms of sethoxydim phytotoxicity.

Table 1. Barley control twenty days after treatment with sethoxydim as influenced by carrier/adjuvant. Visual ratings averaged over four replicates: 0 - no control, 9 - complete control.

Rate (g ai/ha)	Carrier / Adjuvant		
	Water	Water + Oil	Oil
0.0	0.00	0.00	0.00
87.4	4.75	4.50	2.75
174.8	7.00	7.25	4.75
262.2	9.00	8.75	7.75

lsd between carriers at one rate is 1.78

In 1985 sethoxydim activity was increased significantly by both oil adjuvants (Figure 1). Furthermore, the relationship between percent adjuvant and phytotoxicity varied depending on the application volume and method. With the hvra treatments soybean and canola oil were virtually identical in terms of herbicide enhancement. Phytotoxicity increased as the oil volume was increased from 0.5 to 3.5 % but was not affected by further increases in oil concentration. A similar relationship between phytotoxicity and oil volume was observed with the lvra treatments; however in this case soybean oil was significantly more effective than the canola oil in enhancing herbicide activity. With the hvff treatment phytotoxicity increased with increasing canola oil concentration throughout the range tested. Orthoganol contrasts made at the one percent level indicated no significant difference between the oils as carriers (Table 2).

Table 2. Barley control 38 days after treatment with sethoxydim as influenced by carrier. Visual ratings averaged over four replicates: 0 - no control, 9 - complete control.

CARRIER	RATING
water	0.25
crude degummed canola oil + emuls	5.50
crude degummed soybean oil + emuls	6.50
untreated control	0.00
crude degummed canola oil + emuls. control	0.00
crude degummed soybean oil + emuls. control	0.00

Humidity did not affect sethoxydim activity in the growth room test so the data was averaged over both humidities (Table 3). Both oils significantly enhanced herbicide activity when used as carriers or as adjuvants. Soybean oil was significantly more effective as an adjuvant than was the canola oil. There was a similar trend with the carrier data although this was not statistically significant. Furthermore, the soybean oil enhanced sethoxydim activity to the same extent whether it was used as a carrier or as an adjuvant. Canola oil was more effective as a carrier than as an adjuvant.

Table 3. Barley top dry weight 14 days after treatment with sethoxydim as influenced by carrier/adjuvant. Weights are based on pot totals and averaged over six replicates.

CARRIER/ADJUVANT	POT DRY WEIGHT (GRAMS)
Water	1.63
WATER + 6.25% CANOLA OIL	1.44
WATER + 6.25% SOYBEAN OIL	1.16
CANOLA OIL CARRIER	1.18
SOYBEAN OIL CARRIER	1.28
UNTREATED CONTROL	2.14

Discussion

The vegetable oils tested in these studies generally did not enhance 2,4-D (ester) or glyphosate activity. In some cases activity was reduced when the oils were used as carriers or adjuvants with these herbicides.

The oil adjuvants did enhance sethoxydim activity in the 1985 field and growth room studies. This was expected since oil adjuvants are generally known to increase sethoxydim activity. Soybean oil tended to be more effective as an adjuvant than canola oil and this was most pronounced with the low volume treatments. Differences between the oils are likely due to differences in fatty acid content and the corresponding effect on viscosity and the reactivity of the oils. It is possible that rapeseed oil with its higher erucic acid content would be more effective than canola oil.

There was no sethoxydim enhancement with the canola oil

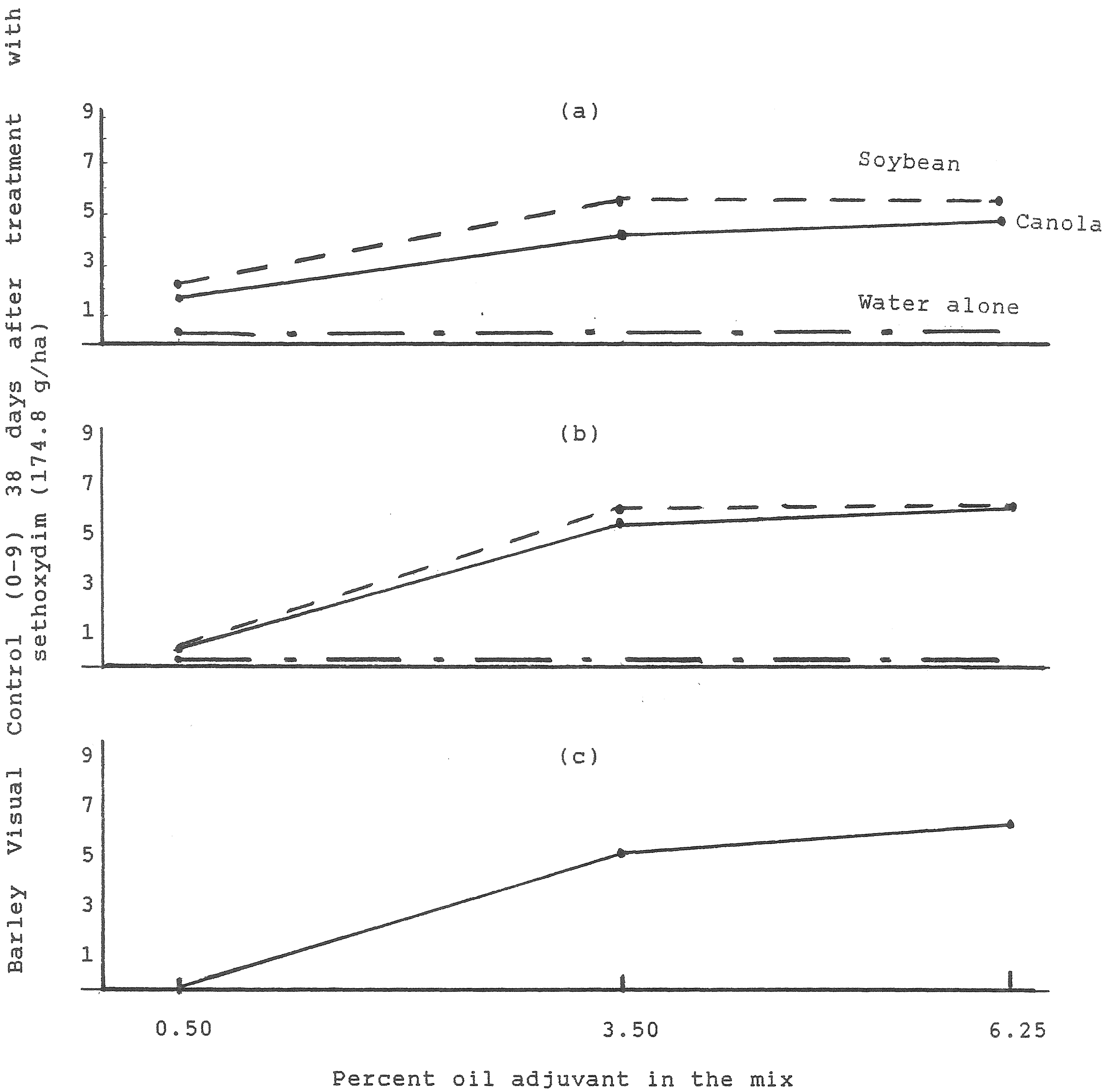

Figure 1. Barley control with sethoxydim as affected by percent oil in the mix. (a) low volume rotary atomizer treatments; (b) high volume rotary atomizer treatments; (c) high volume flat fan treatments.

adjuvant in 1984. This was unexpected as it is generally accepted that sethoxydim phytotoxicity is enhanced by oil adjuvants. Herbicide enhancement with oil adjuvants is thought to be due to cuticle solubilization by the oil resulting in improved herbicide uptake. This is most pronounced when environmental conditions favor thick, waxy plant cuticles and least when conditions favor thin, relatively non-waxy cuticles. Prior to treatment in 1984 soil moisture was adequate and temperatures had not been extreme therefore it is likely that cuticles were relatively thin and non-waxy. This would explain the failure of the canola oil adjuvant to increase sethoxydim activity in 1984.

Although both oil carriers increased sethoxydim activity in the lab and 1985 field tests the higher concentrations of the oil adjuvants were almost as effective, suggesting that these oils are more realistic economically as adjuvants than as carriers.