Tank Mixing of Active VPR PLUS (14-10-10) with Viper ADV Herbicide to Replace UAN (28-0-0) as a tank mix Partner and its Herbicidal Activity

This report consists of three sections to illustrate that Active VPR PLUS (14-10-10) is a better tank mix partner to Viper ADV herbicide vs UAN (28-0-0) in terms of herbicidal activity and promoting crop growth.

In the first section compatibility of the tank mixes (Viper ADV+UAN; Viper ADV+UAN+Active VPR; Viper ADV+Active VPR PLUS) have been evaluated in a field spray simulation using irrigated water available in Saskatoon, SK, Canada. In the second section the herbicidal activity of Viper ADV and Active VPR PLUS tank mix has been evaluated against a Viper ADV and UAN tank mix in a third-party field experiment conducted by New Era Ag Technologies. In the third section, the chemical nature of the mixtures has been discussed to show why Active VPR PLUS is a better tank mix partner to Viper ADV herbicide.

1. **Active VPR PLUS (14-10-10) in a Field Spray Simulation Set up with VIPER ADV Herbicide**

Urea Ammonium Nitrate (UAN) solution is a recommended tank mix partner for Viper ADV herbicide, but our new Active VPR PLUS is a nutritional technology that can replace UAN as a tank mix partner. Active VPR PLUS contains a higher total nutrient analysis (14-10-10) compared to UAN (28-0-0) and provides all three essential elements (N-P-K) required during herbicide timing of peas, lentils, and soybean helping to reduce herbicide stress to the crop.

In this experiment, mixing of Viper ADV herbicide with Active VPR PLUS was compared to Viper ADV with UAN using spray apparatus used in commercial spray units.

According to VIPER ADV label (BASF Canada) application rate for field peas and soybeans is 0.8L/ha in a 100L of water. The label recommends tank mixing of UAN (28-0-0) at the rate of 2L/ha and this will be replaced with 2.5L/ha of Active VPR PLUS in this experiment.

Chemicals were prepared for 10-acre (4.05 ha) application. Table 1 shows the amounts of each chemical added in 400L of water. Figure 1 shows the prepared chemicals and the tank set up for testing.

Table 1. Components of the mixture prepared to assess the compatibility of Active VPR PLUS with Viper ADV herbicide.

Item	Composition
Water	400L
Viper ADV	4.05L
Active VPR PLUS	10L

Figure 1. Chemicals and tank set up for mixing Viper ADV herbicide and Active VPR PLUS. Tank contains 400L of irrigation water. Spray apparatus is attached to the side of the tote.

Irrigation water was used in this experiment (pH: 7.65; sg=0.99g/ml). Clean and dry 1000L tote was used as the tank to mix the chemicals. Spray apparatus was attached to the side of the tank (figure 1) and the bar with the spray nozzles was hanged horizontally inside the tank top (figure 2).

Figure 2. Circulation hose, spray hose (connecting to the spray nozzles) and the bar with the spray nozzles (inside the tank-attached to the tank top).

Chemicals were added using irrigation water, Viper ADV, Active VPR PLUS sequence.

After adding 400L of irrigation water, recirculation and spraying was conducted to ascertain the right pressure and ensure the nozzles were working properly. After the system test, 4.05L of Viper ADV herbicide was added slowly while recirculation was on. 10L of Active VPR PLUS was added soon after Viper ADV and the mixture was left running for 20 minutes before testing the spray. Pump pressure was increased to 30PSI to start the spray. Spray was observed for a four-hour period. During this period, any incompatibility signs (precipitation, cloudiness, frothiness) and spray pattern were recorded as per table 2. Pictures were taken and the process was videotaped.

Table 2. Spray observations of the spray mixture.

Time	Observations
Soon after mixing	Clear solution. No incompatibility signs (no precipitation, separation of liquids or oily layer at the edges of the tote)-**Figure 3.**
30min after mixing	Clear solution. No incompatibility signs, fine spray, all the nozzles work-**Figure 4.**
1hr after mixing	Clear solution. Liquid and the spray same as before. No signs of incompatibility. All spray nozzles working and fine spray-**Figure 5.**
2hrs after mixing	Mixture is clear, no signs of incompatibility, spray is same as at the beginning and fine spray. **Figure 6.**
3hrs after mixing	Spray mixture is clear, no incompatibilities, no building of oil layer or dark material at the top or the edge of the solution. All the spray nozzles are working and fine spray. **Figure 7.**
4hrs after mixing	Clear liquid in the tank and clear spray. No separation of chemicals, no precipitation and no oil floating on the top. **Figure 8.**

After 4 hours of continuous spraying, the 80 mesh screen, spray nozzles and end cap of the spray nozzle bar were removed and observed for any sediments and accumulation of spray material. No materials build up was observed (Figure 9).

Pictures Taken During 4hr Spray Event

Figure 3. Soon after chemicals were mixed

Figure 4. 30min into spraying

Figure 5. 1hr into spraying

Figure 6. 2hrs into spraying

Figure 7. 3hrs into spraying

Figure 8. 4hrs into spraying

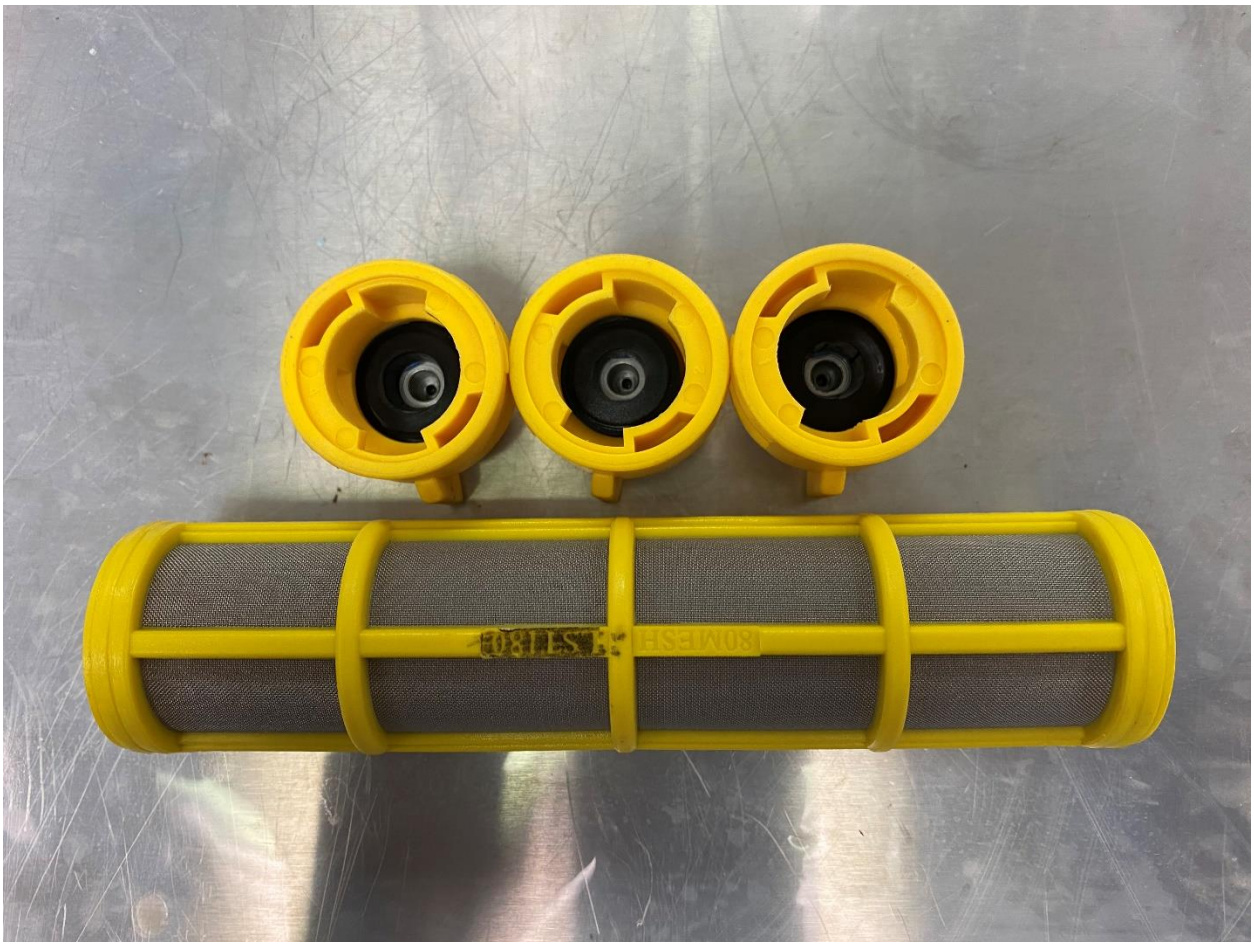


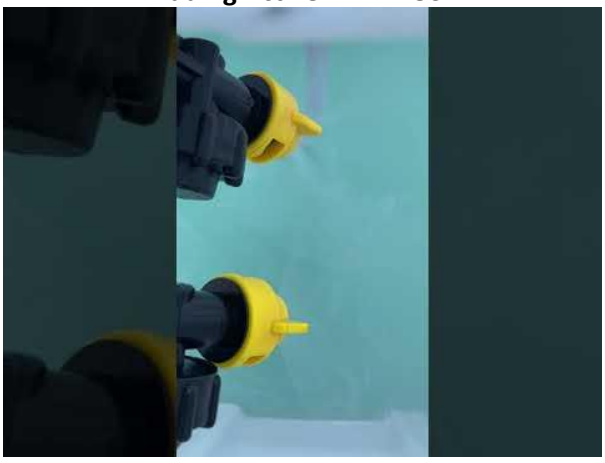
Figure 9. 80mesh screen and spray nozzles at the end of 4hr spray event (clean and clear).

Following links lead you to the spray pattern videos taken during the experiment:

Adding Viper ADV herbicide.

Adding Active VPR PLUS.

1 hour into Spraying.



2 hours into Spraying.

3 hours into Spraying.

4 hours into Spraying.

Based on the above tests conducted we did not observe any signs of incompatibility in the tested mixture. 80 mesh screen, spray nozzles and the end cap of the spray nozzle bar were without any accumulated spray material indicating mixture solutions performed the same during the spray simulation period (indicates no adverse chemical reactions occurred to block the emitters).

2. Herbicidal Activity of Viper ADV and Active VPR PLUS Mixture in growing peas

This is a third-party research trial conducted by New Era Ag Technologies in Swan River Manitoba.

Project lead: Meghan Rose; Bailey Sagert from New Era Ag Technologies

Objective: Is to replace UAN (28-0-0) in Viper ADV tank mix with Active VPR PLUS (14-10-10) and have the same herbicidal activity as Viper ADV+UAN tank mix while enhancing the crop growth.

Treatment protocol:

Check: No application of VIPER ADV, UAN or Active VPR PLUS

Treatment 1: VIPER ADV+UAN at recommended dosage

Treatment 2: VIPER ADV+UAN+Active VPR at recommended dosage

Treatment 3: VIPER ADV+Active VPR PLUS at recommended dosage

Peas were grown in 5'x21' plots. Three replicates were assigned to one treatment. Treatments were applied at when the pea plants at 3 nodal stage.

Treatment layout:

UTC	Viper ADV+UAN	ViperADV+UAN+Active VPR	ViperADV+ActiveVPR PLUS	UTC

Selected area was mainly infected with volunteer canola.

Except for volunteer canola, as the initial weed pressure was low in these plots, therefore a separate section of the field with high weed pressure was selected to evaluate the tank mixes separately.

Following picture shows the weed control ability of the selected tank mixes 10 days after the application.

Based on the observations all three tank mixes had equal herbicidal activity on the weeds present in the ground.

Weeds affected by VIPER ADV+Active VPR PLUS tank mix

Weeds not affected by VIPER ADV+Active VPR PLUS tank mix

Weeds affected by VIPER ADV+UAN+Active VPR tank mix

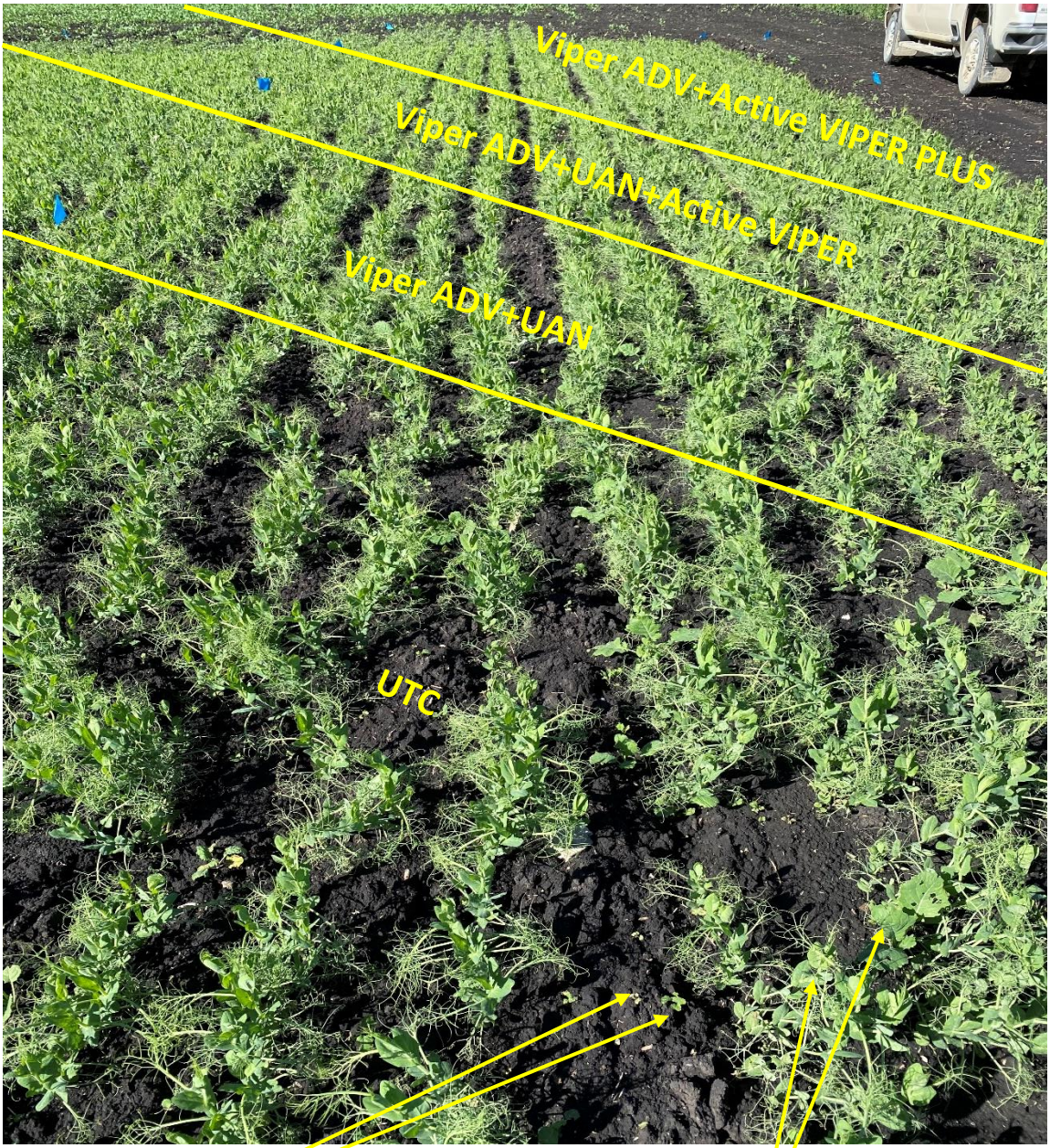
Weeds not affected by VIPER ADV+UAN+Active VPR tank mix

Weeds affected by VIPER ADV+UAN tank mix

Weeds not affected by VIPER ADV+UAN tank mix

Performance of the prepared herbicide tank mixes in growing peas

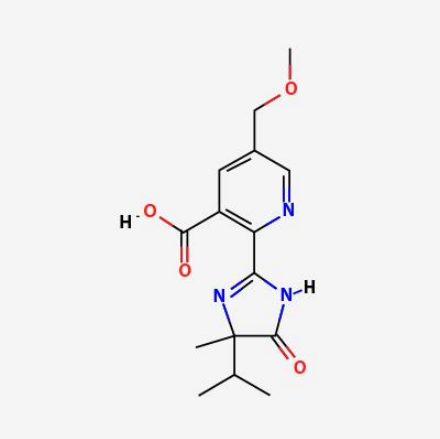
Prepared tank mixes were applied to pea plants at 3 nodes stage. Volunteer canola were the main weed present in the field. Except in UTC plots, all the plots treated with the tank mixes had 100% control of volunteer canola. Plots received Active VPR or Active VPR PLUS had better plant growth and will be evaluated using yield parameters. All the plots except UTC had slight burn of bottom leaves but this did not affect the growth of pea plants.


Viper ADV+Active VIPER PLUS
Viper ADV+UAN+Active VIPER
Viper ADV+UAN
UTC
Other weeds
Volunteer canola

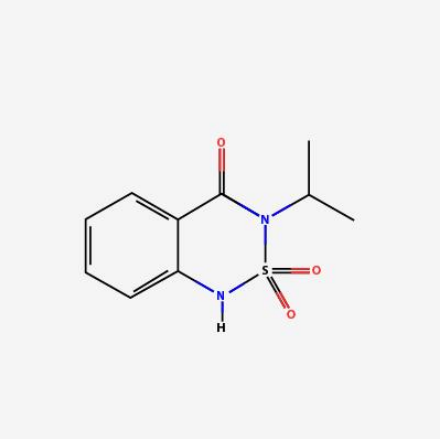
3. **Chemically, why Active VPR PLUS (14-10-10) is a better tank mix partner to Viper ADV Herbicide than UAN (28-0-0)**

Viper ADV herbicide contains imazamox and bentazon as active ingredients and their structures are shown below. N, H and O atoms present in the two molecules are important in making bonds with other compounds when solubilizing in an aqueous medium and enhancing penetration of the cuticle. Making bonds in both hydrophilic and hydrophobic conditions is important for cellular activity of herbicide active molecules. UAN (28-0-0) contains about 75% of urea and 25% of ammonium nitrate. In a tank mix of Viper ADV and UAN, NH^{+4}, NO^{-3}, N and H atoms/ions are involving the bond formation. In a Viper ADV and Active VPR PLUS tank mix, Active VPR PLUS provides urea-potassium-phosphate complex and provides N, H, PO^{-4} and K^{+} atoms/ions to make bonds with active molecules of Viper ADV and facilitates solubilizing and penetrating the complexes through the cuticle. Active VPR PLUS provides better ionic concentration and ionic distribution for formation of bonds in an aqueous solution.

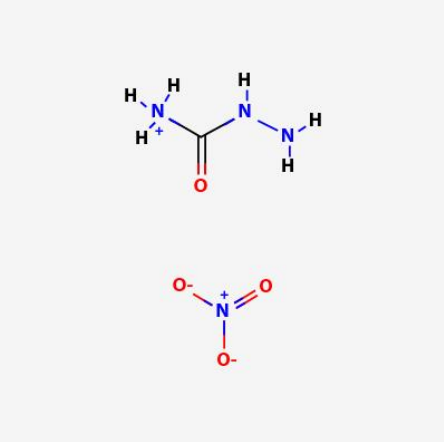
Imazamox



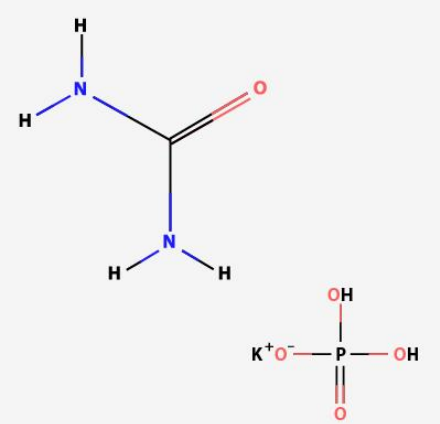
Bentazon



UAN



Active VPR PLUS (14-10-10)



Imazamox chemical name: 2-(4-isopropyl-4-methyl-5-oxo-4,5-dihydro-1H-imidazol-2-yl)-5-(methoxymethyl)nicotinic acid

Bentazon chemical name: 3-Isopropyl-1*H*-2,1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide

The formulation of an herbicide, particularly the adjuvant systems, can significantly influence the efficiency of an herbicide and its uptake and translocation within the plant. Surfactants, urea, UAN and urea-potassium phosphate complexes are active primarily on the leaf surface and reduce surface tension and enhance herbicide uptake, translocation and field performance. Reducing leaf surface tension also help increase the spreadability of herbicide active molecules on a leaf surface giving more surface area for herbicidal activity.

The following published research supports that the addition of compatible fertilizer mixtures enhances the herbicidal activity in cropping systems and even reduced application rates can be achieved and delay the development of herbicide resistance by weeds.

a. El-Metwally, I. M.; Kowthar G. El-Rokiek; Salah A. Ahmed; Ebrahim R. El–Desoki and Emad E. H. Abd-Elsamad. **Effect of Adding Urea or Ammonium Sulphate on some Herbicides Efficiency in Controlling Weeds in Onion Plants.** Journal of American Science 210 6(11) 536-543.

b. Tarek A El-Shahavy. **Chemical fertilizers could offer a real solution for minimizing over consumption of herbicides for controlling weeds in Faba Beans (Vicia faba L.).** Trends in applied sciences research. 3(2):142-153 2008

Thus, adding urea solutions (urea, Active VPR PLUS/urea-potassium phosphate, urea-ammonium nitrate) are helpful in getting herbicide mixtures such as Viper ADV and Python into the target weeds.

Overall Conclusion

Based on spray simulation and field efficacy trials conducted, Active VPR PLUS is compatible with Viper ADV herbicide and did not reduce herbicidal activity of Viper ADV. While helping to combat herbicide stress to the crop Active VPR also provides a better nutritional value compared to just UAN. Therefore, Active VPR PLUS is a better tank mix partner to Viper ADV herbicide.

Report from New Era Ag Technologies

Table 1: Herbicidal activity of VIPER ADV+Active VPR PLUS tank mix		
Objective: To test the herbicidal efficacy of VIPER ADV+Active VPR PLUS and VIPER ADV+UAN+Active VPR tank mixes against VIPER ADV+UAN tank mix in peas		
Variety: Abarth	Plot Size: 16ftx16	Soil Moisture: low Soil Temp: 20C
Seeding Date: July 30, 2020	Row Spacing: 12in	In-season rainfall:
Seeding Depth: 1.5inches	Number of rows: 16	
Seeding Rate: 190lbs/ac	Number of reps: 1	
Fertilizer: none		

Table 2. Treatment combinations, application rates and timing of application:

Treatment #	Product	Rate	Timing
A	UTC		
B	Viper ADV + UAN	400ml, 800ml/ac	prior to 6 node
C	Viper ADV + UAN+ Active VPR	400ml, 800ml, 1L/ac	prior to 6 node
D	Viper ADV + Active VPR Plus	400ml, 1L/ac	prior to 6 node

Table 3. Field layout of the treatments:

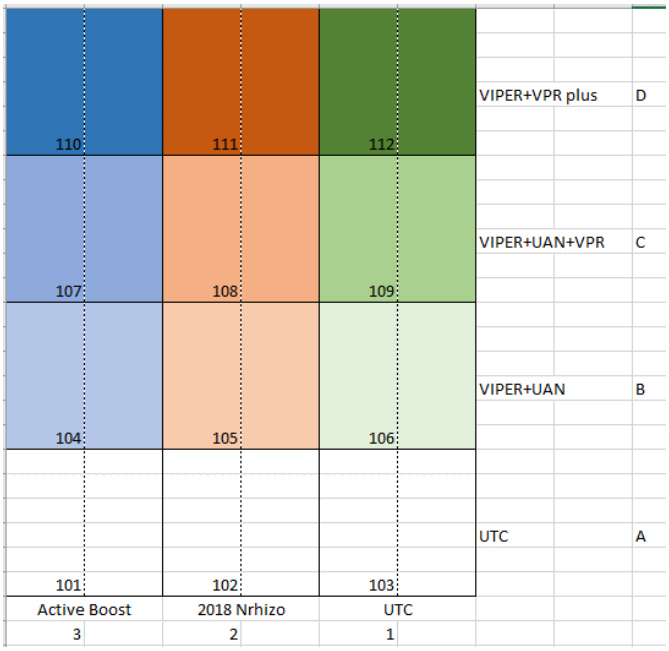


Table 4. Ratings and timing:

Ratings		Timing
1	**Nodule Counts**	45days after planting (September 13?)
	10 plants at three locations per treatment (1,2,3)	or 6 node whichever is first
2	**Herbicide injury**	5-7 days post application
	rate phytotoxicity on a 1-10 scale	
3	**Herbicide efficacy**	5-7 days post application
	1-10 rating scale	10-14 days post application
4	**Plant vigor**	prior to herbicide application
	1-10 scale	5-7 days post herbicide application
5	**Pod counts**	end of flower/pod filling

Table 5. Plant vigor and phytotoxicity data:

Plant vigor and phytotoxicity ratings on Abarth peas					
Rating		**Plant Vigor**		**Phytotoxicity**	**Pod counts**
Timing		pre-herb	post herb	7 days post app	
Scale/Units		1-10 scale	1-10 scale	0 - no symptoms	
Rating DATE		24-Aug		10 - plants dead	
Plot	Treatment #				
101	3A	10	10	0	
102	2A	10	10	0	
103	1A	10	10	0	
104	3B	10	10	0	
105	2B	10	10	0	
106	1B	10	10	0	
107	3C	10	10	0	
108	2C	10	10	0	
109	1C	10	10	0	
110	3D	10	10	0	
111	2D	10	10	0	
112	1D	10	10	0	

Table 6. Affected weeds and efficacy rating of herbicidal activity of each tank mix:

Treatment	V. canola	buckwheat	lambs quarters	cleavers	smartweed	barnyard grass	pigweed
VIPER+UAN	3	2	2	2	1.5	1	2
VIPER+UAN+VPR	3	na	na	1.5	2.5	na	1.5
VIPER+VPR plus	3	na	na	3	2	1	2.5
na-particular weed is not present							
0 - no effect							
1- yellowing/stunting							
2-yellowing and necrosis							
3->50% necrotic							

Discussion:

Peas were seeded July 30th with appropriate inoculant for each treatment. No fertilizer was applied at seeding.

Peas emerged quickly and evenly across all treatments.

There was not a good variety of weeds in the seeded area, so two grids were sprayed, one to measure phytotoxicity in the peas and one to measure efficacy of the herbicide on a wider selection of weed species. Both trials were sprayed on August 24th.

In the 7 to 14 days post herbicide application there were no visual differences in pea plants across all treatments. There were no notable delays in growth and development or yellowing or necrosis of any plant tissues.

Table 6 provides the weed species and efficacy ratings for each spray treatment. There were various stages of each weed species from cotyledon to flowering. Ratings focussed on the smaller weeds that would be present in a spring herbicide application. The differences in the treatment ratings are influenced by the size and stage of the weeds found in each treatment strip. The general visual rating when assessing the entire treatment area was that the herbicide performed equally across all treatments. There was one area in the VPR-UAN treatment that had larger canola plants. The treatment had a lower efficacy on these plants but was not assessed as part of the ratings in table 3 as this would be abnormal during spring herbicide treatments.

Our observations were that Active VPR + UAN and Active VPR PLUS when mixed with Viper herbicide had comparable weed control efficacy as Viper and UAN.

Labelled pictures of the trial can be found in this dropbox link.

Aug. 28th pictures from Pea plots (application was done on 24th of Aug)

1. **VIPER ADV+UAN**

2. **VIPER ADV+Active VPR PLUS**

3. VIPER ADV+UAN+Active VPR

Aug. 28th pictures from weed plot (application was done on 24th Aug)

1. **VIPER ADV+UAN**




2. VIPER ADV+Active VPR PLUS

3. VIPER ADV+UAN+Active VPR