The effect of organic Alfalfa Green on yield and overall performance of different vegetables

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Abstract
An organic fertilizer, Alfalfa Green, was tested for its effects on yields of radishes, beans, beets, pumpkins, onions, potatoes, and lettuce. The equivalent of 1mt/ac and 2mt/ac along with an untreated control were used over two replicates. In certain vegetable types AG was found to boost germination rates and total yield.

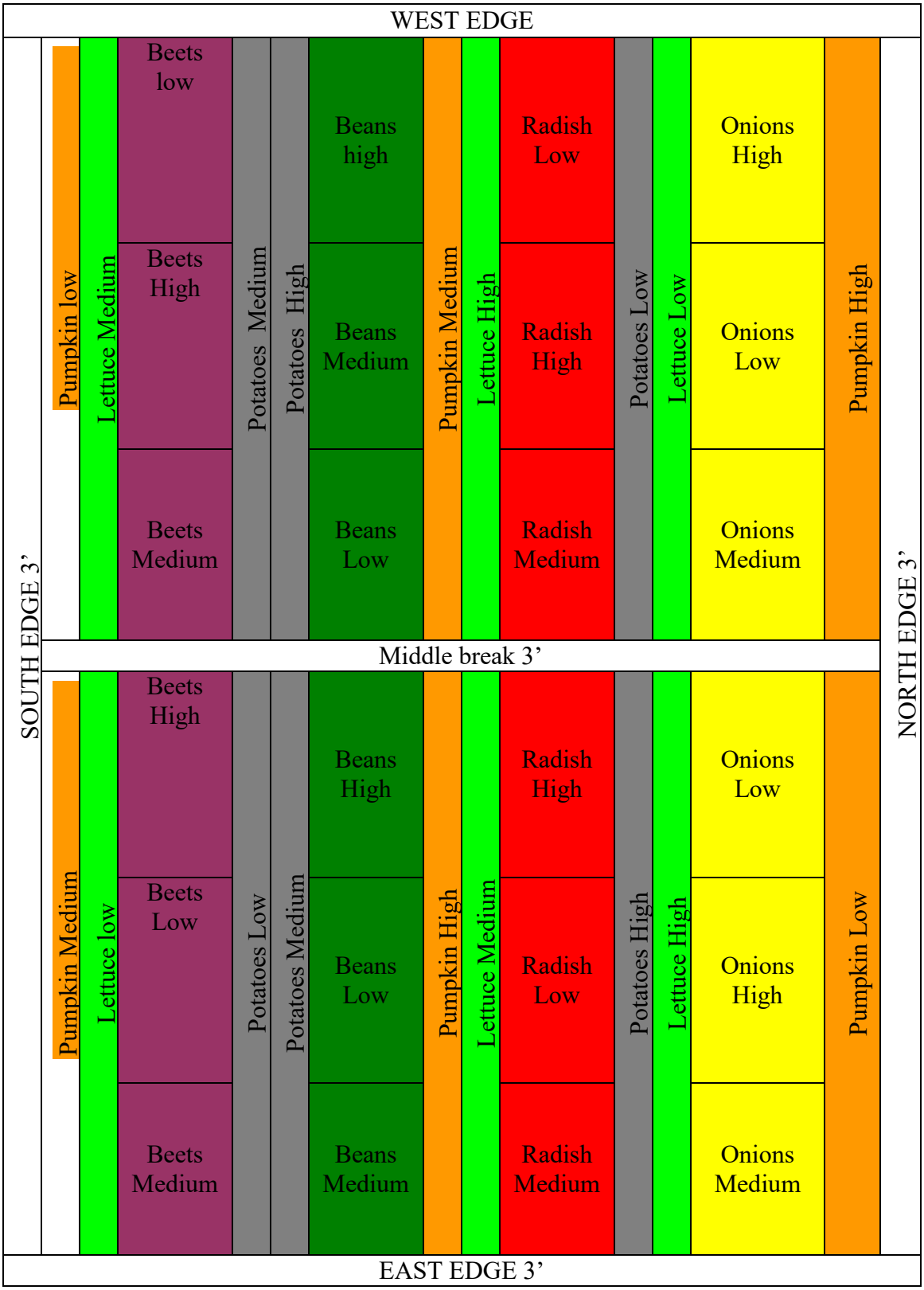
Introduction
Western Alfalfa Milling Co. Ltd (WAMCO) produces an organic 3-0-2 fertilizer, Alfalfa Green (AG). Widely used as an organic fertilizer for lawns and municipal green spaces, AG is advertised as being suitable for virtually all fertilizer settings, including for use in vegetable gardens. While there have been numerous testimonials by its users regarding the positive effects of AG on vegetables, there has not been any formal research done in this area. In the spring of 2010 WAMCO set out to test different application rates of AG on seven different vegetable types.

Vegetables from seven families were selected: *Fabaceae* (green beans), *Asteraceae* (lettuce), *Solanaceae* (potatoes), *Cucurbitaceae* (pumpkin), *Alliaceae* (onions), *Chenopodiaceae* (beets), and *Brassicaceae* (radish). Vegetables were treated with one of three application rates of AG and were then measured for certain traits including overall yield, total weight, average weight, germination rate, and survival rate.

Materials & Methods
Three rates of AG were selected to be tested: One control at the equivalent of zero tonnes (mt) per acre (ac) which was designated as the low treatment, a medium treatment at the equivalent of 1mt/ac, and a high treatment at the equivalent of 2mt/ac. Each treatment was replicated twice. The actual weight of pellets applied was determined by using the length of each treatment (as outlined by the seed manufacturer's recommendations for seed spacing) and multiplying that by the 1' row width for the treatment. This total treatment square footage was then calculated as a percentage of an acre, and from here the weight of pellets required was determined.

A three-foot space was allotted between each row, including around the outside perimeter of the entire trial. The exception is the pumpkin rows, where a six-foot space was allotted in all directions. A three-foot space also split the rows down the middle. Rows were set up at a width of one foot each as shown in the following diagram:

Figure 1: Outline of seeding placement



Where treatments occurred within one row (i.e. beets), one-foot was allotted vertically between each treatment.

Initially, 15 seeds for each treatment were to be used, but in certain treatments environmental conditions caused an alteration to this plan as outlined below. Alfalfa Green was to be applied one week prior to seeding and then naturally hand-mixed into the soil at the time of seeding, but due to excessively wet conditions, seeding and AG treatments were a bit late for most crops. Manufacturer's instructions for most of the vegetables also indicated ideal growing conditions when moisture is greater than 1" per week. Therefore, when rainfall was less than 1" per week all rows were watered with the necessary quantity of water. Treatments went as follows:

Onions:
There was a communication error in determining the weight of AG to be applied. Therefore, 0.12kg was applied to the medium treatments, and 0.24kg to the high rows. This equates to an equivalent application rate of 1.2mt/ac and 2.4mt/ac. AG was applied to all onion rows on May 13. Onions were seeded on May 20 2.5cm apart and about 4.5cm deep. Due to human error, only 11 bulbs were planted in the east medium row. The onions were harvested on August 18th.

Beets:
AG was applied to all beet treatments on May 13 at a rate of 0.12kg for the medium and 0.24kg for the high treatment. Beets were seeded on May 20 3cm apart and 1.1cm deep. The west low treatment only received 14 seeds due to human error. The beets were harvested on August 18th.

Radishes:
AG was applied to all radish rows at a rate of 0.06kg for the medium and 0.12kg for the high treatment on May 18. Radishes were delayed getting seeded due to excessive moisture. We ended up seeding them on June 2nd 1" deep and 2" apart. The east radishes were harvested on July 11th and the west rows on July 12.

Green Beans:
AG was applied on May 20 to the green bean rows at a rate of 0.10kg on the medium and 0.20kg on the high treatment rows. Beans were seeded June 2nd and were planted 1.5" deep and 3" apart. Harvest of all rows occurred in three stages[1] on August 9th, 17th, and 25th.

Pumpkins:
AG was applied to all pumpkin rows at a rate of 0.43kg for the medium and 0.86kg for the high rows on May 18. Pumpkins were seeded 12" apart and 1" deep on May 27. While we aimed to harvest all pumpkin rows at the same time, given the overwhelming

[1] The first time we harvested we noticed a significant difference within trials as to the beans size as not all were ready for harvest. Therefore, we opted to repeat the harvest an additional two times. During the first two trials we picked only those beans which were greater than 3" in length, while on the final trial we harvested all the beans.

yield and limited man power we ended up harvesting over four days. The low west row was harvested Sept. 13, the high west and medium east Sept 14, the medium west Sep 15, and the low east and high east on Sept 17.

Potatoes:
AG was applied to all potato rows at a rate of 0.46kg on the medium and 0.92kg on the high rows on May 20. Potatoes were seeded 4" deep and 12" apart on May 27. Potatoes were hilled on July 6th, July 12, and Aug 6th. The east rows were harvested on September 3rd, and as they were still fairly small, the west rows were not harvested until October 5th.

Lettuce:
AG was applied to all lettuce rows at a rate of 0.43kg for the medium and 0.86kg for the high rows on May 18. Lettuce was seeded on May 27 14" apart and 0.5" deep, but due to human error (and extremely blustery conditions) the number of seeds actually seeded is unknown. Therefore, lettuce results are weight and survival based rather than yield based. The east rows were harvested August 9th, and the west rows on August 17th.

Watering of 1" occurred on all rows on May 19 and 0.6" on Aug 6th. On average, more than 1.2" of rain fell during all other weeks, with some wet weeks in June pouring over 3" per week. Overall, 20.4" of rain fell during the 16 weeks the rain gauge was monitored.

Results
Due to limitations in personnel to assist with the harvesting of our vegetables, some vegetable rows were harvested at different times than other rows of the same.

Germination rates were measured on June 21st.

Radishes
Figure 2: Radish Results:

Treatment	Germination %	Survival Rate (%)	# Radishes	Biomass (g)	Total Radish Wt (g)	Average Wt per Radish (g)
Low Total	73	59	13	199.1	183.8	14.14
Med Total	73	68	15	266.0	139.7	9.31
High Total	83	64	16	174.1	154.7	9.67

Lettuce

Figure 3: Lettuce results

Tre	# Heads	Survival %[2]	Total Head Wt (kg)	Avg. Wt per Head (kg)	Total Circumference (cm)	Avg. Circumference per head (cm)	Largest Head Circumference (cm)
Low	12	71	17.0	1.42	845	70.42	86
Med	12[3]	86	12.1	1.10	742	61.83	83
High	6	55	7.55	1.26	446	74.33	88

Onions

Figure 4: Onion results

Treatment	Germination %	Survival %	# Onions	Total wt (g)	Avg. Wt per onion (g)	Total Onion Circumference (cm)	Avg. Circumference per onion (cm)	Largest onion circumference (cm)	Heaviest Onion (g)
Low	80	42	10	1700	170	189	18.9	24.0	250
Med	77	65	13	1950	150	196	15.1	24.0	300
High	90	48	13	1150	88.5	176	13.5	19.0	150

Beets

Figure 5: Beet results

Treatment	Germination (%)	Survival %	# of Beets	Total wt (g)	Avg. Wt per beet (g)	Total beet circumference (cm)	Avg. Circumference per beet (cm)	Largest beet circumference (cm)	Heaviest beet (g)
Low	40	100	12	8150	679.2	281	23.4	32.0	1250
Med	70	81	17	6500	382.3	337	19.8	28.0	650
High	69	90	18	4350	241.7	313	17.4	33.0	1150

[2] This is based on the number of heads that were observed to have germinated as of June 21st. As the number of seeds was not known, a germination % is unavailable.

[3] This includes one head that was not noticed until several days post-harvest as it was buried under the pumpkins. This head had a reasonable diameter and is estimated to have been approximately 1kg, but was not weighed or measured and it is not included in determining average weight.

Beans

Figure 6: Bean results

Treatment	**Germination %**	**# Beans**	**Total Wt (g)**	**Avg. wt per bean (g)**	**Longest Bean (in)**	**Avg. Bean Length (in)**
Total Low	93.3	**398 regular**[4], 69 medium, and 74 small	3305.3 for regular, 310.0 for medium	**8.30 for regular,** 4.49 for medium	6.5	5.06
Total Med	76.7	**294 regular**, 48 medium, and 49 small	2407.4 for regular, 200.5 for medium	**8.19 for regular**, 4.18 for medium	7.1	5.29
Total High	76.7	**278 regular**, 85 medium, and 22 small	2390.6	**8.60 for regular,** 5.24 for medium	6.7	5.02

Potatoes

Figure 7: Potato results

Treatment	**Germination (%)**	**#Total number of Potatoes**
Low	100	293
Medium	100	257
High	100	272

Pumpkins

[4] Regular beans were those >4", Medium were 2-4", and small were <2".

Figure 8: Pumpkin results

Treatment	Pumpkin Size	Germination (%)	# pumpkins	Total Pumpkin weight (kg)	Average weight per pumpkin (kg)	Heaviest Pumpkin (kg)
Low	Normal[5]		51	153.1	3.00	5.30
	Medium[6]		36	47.25	1.31	
	Small[7]		40	8.20	0.21	
	Total	53.3	127	335.55	2.64	
Medium	Normal		35	97.05	2.77	5.95
	Medium		44	56.70	1.29	
	Small		53	11.45	0.22	
	Total	53.3	132	165.20	1.25	
High	Normal		42	120.7	2.87	5.50
	Medium		53	72.15	1.36	
	Small		67	16.90	0.25	
	Total	56.7	162	209.75	1.29	

Discussion

Radishes

There was a significant difference in the germination rate of the radishes in the high treatment compared to either the low or medium treatments. Perhaps by having a better nutritional base in the soil, the seeds were better able to germinate, and consequently thrive.

The average weight per radish and total radish weight were significantly higher for the low treatment compared to either treatment that received AG. This is perhaps due to competition – as there were fewer radishes in the low treatment, those that did grow had better access to nutrients and less competition for those nutrients as well as physical space to grow. Under the medium and high treatments, because there were more radishes, there was more competition, and as a result the growth of all radishes could have been inhibited.

We noticed a significant increase in total biomass of the medium treatment. This was unexpected, and leads us to the conclusion that perhaps the N in the medium treatment was put towards leaf and stem development, rather than towards radish development. We do not have an explanation as to why this would occur.

While further works could be done, these results indicate that AG does have a benefit in terms of increasing radish yield and germination when used at the equivalent of two tonnes per acre.

[5] Normal was determined to be those pumpkins with a weight greater than 2kg.
[6] Medium was determined to be those pumpkins with a weight of 0.5 to 1.9kg.
[7]Small was determined to be those pumpkins with a weight less than 0.5kg

Lettuce
Our lettuce results found that the medium treatment had a 15% better survival rate than either of the other treatments.

Both medium, one high, and one low treatment were situated directly adjacent to the pumpkin rows. The pumpkins over took our garden and their extensive growth may have had a detrimental impact on lettuce growth, as the lettuce were largely covered by the pumpkins and did not receive direct sunlight.

We found that the low treatment performed better than either of the AG treatments in every category except survival and head circumference. The lettuce under the low treatment appeared to be denser, keeping their leaves tighter around their centre, rather than expanding outwards with lighter leaves. The average head circumference was largest in the high treatment, indicating that perhaps the opposite happened in the high treatments – the lettuce expanded width-wise rather than keeping its mass centered in the middle.

Overall these results show that AG has a minimal effect on lettuce development, although further studies should be performed.

Onions
The onions appeared to perform best when AG was applied at the equivalent of 1mt/ac. While the germination was significantly better for the high treatments, the medium treatment did best in most other categories including survival, overall yield, total weight, total circumference, and largest and heaviest onions.

The low treatments averaged heavier onions. This is best explained by looking at competition levels. As there were fewer onions in the low treatment, there was less competition for limited soil nutrients and physical space, and therefore the onions were bigger.

Overall our results indicate that when AG is used at the equivalent of 1mt/ac there are visible benefits to onion performance.

Beans
Overall germination rates were significantly higher for the low treatments, and therefore the low treatment also yielded the highest number of beans. However, the average bean weight was highest for beans in the high treatment for both regular and medium sized beans, and the medium treatment yielded the longest beans.

Beans are a legume and are able to fix nitrogen from the air. As such, their requirements for N are dramatically reduced and an N-based fertilizer would have a lower effect.

Beets

Germination rate for the beets was 30% better on the plots treated with AG vs. the low treatment. However, survival was much better in the low treatment than in either of the AG treatments.

The high treatment yielded the greatest number of beets, as well as the largest beet circumference. Despite this, the beets were significantly lighter than those in the low treatment. Competition likely had an impact on this, as there was a physical limitation to how large the beets could grow. We observed significant 'bunching' of the beets upon harvest, as those in the medium and high treatments were all quite close together, while those in the low treatments were much more spread out.

These results indicate that AG can have a significant impact on the performance of beets, but one should allow extra space between seeds so as to allow the beets to reach their full size potential.

Pumpkins

AG was found to have a significant impact on pumpkin performance when used at the equivalent of 2mt/ac.

Overall none of the pumpkins germinated particularly well, but all seeds were much more prolific than expected. There was a significant increase in pumpkin yield of the high treatments, but a much greater number of small pumpkins. This is perhaps indicative that the high treatment gave the pumpkins the nutrients they required in order to have abundant yields, and the life of the flowering season was extended. While the low and medium treatment may have stopped flower production earlier, the high treatment kept on flowering, resulting in there being more small and medium pumpkins ready come harvest time. As well, it turned nutrition over for reproduction rather than growth of the existing pumpkins, which explains why there were fewer of the 'normal' sized pumpkins.

Potatoes

As our harvest for the potatoes was not completed close enough together to make categories such as weight and size relevant, we must base our pumpkin results entirely on the yield observed. There was no significant difference between yields in any of the treatments.

Conclusions

AG was found to have a beneficial impact on radish, onions, beets, and pumpkin growth. Further studies should be performed to determine if these results are consistent with other vegetables in each family, such as cress, garlic, spinach, and squash respectively. AG was found to be less necessary for bean, lettuce, and potato production, and further studies should examine whether this is consistent with other vegetables in those families as well.

Appendix

Figure 9: Alfalfa pellets on the pumpkin high surface 9 days after pellet application and just before seeding.


Figure 10: A row of beans July 12


Figure 11: A row of beets July 12

Figure 12: Lettuce July 12

Figure 13: Onions July 12

Figure 14: Potatoes July 12

Figure 15: Pumpkins July 12

Figure 16: Lettuce July 27

Figure 17: Beans July 27

Figure 18: Beets July 28

Figure 19: Pumpkins July 28

Figure 20: Radishes at harvest July 11

Figure 21: Lettuce harvested August 6


Figure 22: **Some of the more than 1300 beans harvested in August**


Figure 23: Pumpkins taking over the field Sept 3

Figure 24: Potatoes at harvest Sept 3

Figure 25: Some of the more than 400 pumpkins harvested in September