Organic Oat Variety Evaluation

Final Report to Certified Organic Producers Co-Op

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Summary

In response to the visit by Grain Miller's in 2015, where they indicated they were interested in procuring organic oats from PEI at a then indicated price of $400.00 /tonne, an organic oat cultivar evaluation trial was initiated on certified organic land at the Harrington Research Farm of the Charlottetown Research and Development Centre in 2016. It was realized that oats are currently evaluated under conventional agricultural production where fertilizer and weed management regimes are optimized. Under organic production, weed pressure may be higher and fertility lower. Thus, cultivars may respond differently under organic production systems than under conventional. For this reason, six hulled oat cultivars currently on the recommended list for PEI, one hulless cultivar and common seed (many organic producers save seed and thus plant what is termed "common seed") were tested. The hulled cultivars were Nova, Canmore, Kara, Rigodon, Nicholas, Orrin and common while the hulless cultivar was Navaro. A latinized three X three split plot design was used in 2016 and a latinized four X four split plot design was used in 2017. The main plots were Nutri-wave pelleted chicken manure (4-1-2) applied at 8, 16 and 32 kg N/ha in 2016 and 0, 8, 16 and 32 kg N/ha in 2017. The subplots in both years were the various oat cultivars. In both years and for the combined analysis, there was a significant effect of the cultivars on yield. The hulless cultivar Navaro and the hulled cultivar Nova were consistently among the lowest yielding. In many instances the hulless varieties did not make the Winchester bushel weight criteria of Grain Millers; in some instances the higher yielding cultivars had lower bushel weights. Producers should look at the data presented in this report and consult with Grain Millers regarding variety to be grown. The addition of the Nutri-wave did not affect oat yield in 2016 but did in 2017. In 2016, soil N appeared to be sufficient to meet the N nutritional requirements of the oats. The interaction between rate of Nutri-wave addition and cultivar was significant for the combined analysis evaluation. This indicates that overall, the yield response differed among the various cultivars.

Background:

Oats on PEI: Oats are a common grain that has been produced on PEI for generations with the majority of farmers having experience growing it. In the last 10 years the acreages of oats have been relatively steady at approximately 10.5 thousand acres with an average yield of approximately 1.1 tonnes per acre (Table 1). However, the acreage is actually much higher when mixed grains are included, approximately 8,000 acres (Table 2). Currently oat testing on PEI is conducted at the Harrington Research Farm under conventional management which includes optimal fertilizer and weed control regimes.

Grain Millers Visit:

Grain Miller's has been in existence for more than 20 years and has been a leading manufacturer of conventional and organic whole grain ingredients used in cereals, breads, bars and many other products served around the world. These grains include oats, wheat, barley and rye, which is milled into flours, flakes, brans and fibers.

Last summer the Certified Organic Producers Co-op (COPC) hosted a brief meeting which included organic farmers, researchers and extension staff to listen to a presentation from Grain Miller Ltd. regarding the procurement of certified organic oats for their company from the Maritimes generally and Prince Edward Island specifically.

There are a number of good reasons to pursue organic oat production on PEI. The first, as indicated, is that this is not a new commodity for PEI and thus local farmers have a history of producing it- thus no surprises for producers. The second is that many conventional farmers are interested in either transitioning all or a portion of their farm to organic in an effort to increase profitability- producers currently receive $ 160.00/tonne for conventional oats whereas Grain Millers was offering $400.00/tonne in their visit. The third reason has to do with diseases. Fusarium head blight is one of the most devastating diseases in most cereal crops due to the toxins that it produces. It is the major reason limiting wheat acreage in the Maritimes. Grain Millers were interested in procuring non hulled oats. The hulls help prevent the Fusarium disease from getting to the oat kernels.

COPC Farmer Researcher Day:

On March 2, 2016 COPC hosted a farmer/researcher day in an effort to establish some research priorities for the organic industry on PEI. There was a lot of discussion on growing oats to meet the Grain Millers demand. From this discussion a couple of points became clear. The first point was that the current testing of oat varieties is under conventional management and weed control where fertility and weed competition probably do not limit yields. It is from this testing cultivars with the highest yield potential are selected. This is probably not applicable to organic producers who do not have quick fixes such as fertilizers and sprays. In their systems yield potential may be limited by fertility and weed pressure. It became very apparent at this meeting that the organic producers are more interested in cultivars with the greatest yield stability not those with the greatest yield potential. For this purpose we are defining cultivar yield stability as those cultivars which perform well under both high and low yield potential environments.

Materials and Methods:

Two trials (2016 and 2017) were initiated to determine how selected cultivars from the current oat recommended list for PEI preformed under organic management. These cultivars were grown in the certified organic block at the Harrington Research Farm of Agriculture and Agri-Food Canada's Charlottetown Research and Development Centre. The cultivars for the two years of the trial were: the hulled cultivars Nova, Nicholas, Canmore, Rigodon, Kara, and Orrin, the hulless cultivar Navaro and common seed that was saved from previous trials. These cultivars were evaluated in split plot latinized designs where the level of N addition (kg N ha^{-1}) from Envirem's Nutri-wave pelletized chicken manure constituted the main plots and the oat cultivars constituted the spilt. In 2016, three N rates 8, 16 and 32 kg N ha^{-1} whereas in 2017 four N rates 0, 8, 16 and 32 kg N ha^{-1} were applied as Nutri-wave 4-1-2. We are cognizant that along with the N addition, P and K were applied as well. Monitored were yield, 1000 kernel weight, and bushel weight. Though the rates of application of the pelletized chicken manure were

based on N, it also proved P and K. Avery bushel weights are presented. Further, in 2017 the height of the plants (which would correspond to straw yield) and the date of maturity of the plants under the various treatments were also recorded. Statistical analysis was preformed using Genstat. Large residuals were removed during the analysis which may result in the mean presented in the combined analysis not equalling that of the arithmetic mean for the two years.

Results and Discussion:

Grain yield, bushel weight and 1000 kernel weight in both growing seasons and for the average of both growing seasons was significantly affected by the cultivars tested (Table 3 and 5). As expected the lowest yield was with the hulless cultivar Navaro (Table 3 and Table 4); it, however, had the greatest bushel or hectare litre weight (Table 3 and 4). Highest yields were generally attained with the cultivars Nicholas, Orrin, Kara and Canmore (Table 3 and 4). Only Canmore and Nova were consistent in making the bushel weight cut off of Grain Millers (38 lbs/Winchester bushel) (Table 4). The cultivars that Grain Millers are recommending that were tested are Orrin, Nicholas, and Kara. The cultivars Canmore, Nova and Rigodon are on their non-preferred list. At this time within their preferred list Kara and Orrin are the closest to meeting their criteria. Thus, organic farmers will have to evaluate yield vs bushel weight to determine the most profitable cultivar to grow. With regards to 1000 kernel weight, like bushel weight, Navaro was the lowest of the cultivars tested in both years and for the combined analysis. Orrin was second in ranking throughout the trial for this parameter.

In the 2016 growing season there was no response in yield of the cultivars to increased rate of N application as pelletized chicken manure nor was there any interaction between N rate and cultivar (Table 3). There was however a quadratic response with regards to bushel weight; higher bushel weights were attained with the 9 and 32 kg N/ha treatments (Table 3). This suggests that the soil N supply at this site in this year was sufficient for the production of oats. There was no effect of N rate on 1000 kernel weight in that year (Table 5).

In the 2017 growing season, however, there was a linear response in yield by the cultivars to increase application rate of the Nutri-wave (Table 3 and 5; Figure 1). There was however, a linear response to applied N for bushel weight, however, besides the 8 kg N/ha treatment the lowest bushel weight, no other trends are discernable. N rate did not affect 1000 kernel weight (Table 5).

For analysis of the two years combined, there was no effect of N rate on yield, bushel weight or 1000 kernel weight (Table 3 and 5). There was however, a significant interaction between cultivar and N rate for all of these parameters (Table 3; Figure 2). The significant interaction between N rate and cultivar for the combined analysis of yield may be due to the yield of Navaro, the hulless oat, decreasing with increasing application rate whereas with the other cultivars, yield generally increased with increased application rate (Figure 2); the rate of increase amongst the cultivars may not have been similar, also causing the interaction. For bushel weight and 1000 kernel weight, the reasons for the significant interaction in the combined analysis are probably similar to that of yield (Table 3 and 4; Figure 3 and 4).

In 2017 straw height and heading date were also evaluated. For straw height there were significant differences among the cultivars and effect of N rate (Table 5). The "common" oat had the tallest straw whereas Kara had the shortest. Generally oat straw height, indicative of straw yield, increased with application of the pelletized chicken manure (Table 5; Fig. 5). There was a significant interaction between cultivar and N rate for heading date in 2017 (Table 5; Fig. 6). Heading date of some cultivars like Navaro, Common, Orrin, and Nicholas do not appear to be influenced by N rate whereas with the others, heading date appears to decrease with increased N rate (Fig. 6). This is a little unexpected since increased application of N usually delays crop maturity.

Conclusions:

This is only two site years of data, however, it is still possible to draw some preliminary conclusions. There is good potential to increase the acreage of organic oats on PEI if market conditions remain strong. Grain Millers use the Winchester standard for bushel weight which is of smaller volume than the Avery standard used in Canada. Some of the higher yielding cultivars have lower bushel weights and thus may not make Grain Miller's standards. Thus, producers need to evaluate their yield potential vs bushel weight to determine what is optimal with regards to returns for them.

References:

Statistics Canada, 2017. 2016 Census of Agriculture. https://www.princeedwardisland.ca/en/information/agriculture-and-fisheries/agriculture-statistics
Accessed March 2018.

Table 1. Oat production statistics for PEI from 2005 to 2016 (Statistics Canada 2017).

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Seeded area (acres)												
8,892	12,597	12,103	12,103	12,103	11,609	11,115	10,374	11,115	8,398	13,091	9,880	11,115
Harvested area (acres)												
8,892	**12,597**	11,609	12,103	12,103	11,609	10,374	9,880	10,374	8,398	13,091	9,386	10,868
Average yield (tonnes per acre)												
1.09	0.97	1.05	1.09	0.89	1.05	1.05	1.09	1.13	1.01	1.09	1.17	1.06
Average yield (tonnes per hectare)*												
2.7	2.4	2.6	2.7	2.2	2.6	2.6	2.7	2.8	2.5	2.7	2.9	2.6
Production (metric tonnes)												
9,700	12,300	12,100	13,000	10,700	12,200	11,000	10,900	11,600	8,500	14,100	10,900	11,417

*tonnes per hectare was determined from the tonnes per acre yield by multiplying by 2.47.

Table 2. Mixed grain production statistics for PEI from 2005 to 2016 (Statistics Canada 2017).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Seeded area (acres)	---	10127	9880	7904	6916	7410	8398	7904	5928	---	---	---
Harvested area (acres)	---	9386	9386	7904	6916	7410	7904	7904	5928	---	---	---
Average yield (tonnes per acre)	---	1.01	0.93	0.93	0.89	1.09	1.01	1.09	1.13	---	---	---
Average yield (tonnes per hectare)*	---	2.5	2.3	2.3	2.2	2.7	2.5	2.7	2.8	---	---	---
Production (metric tonnes)	---	9500	8800	7300	6200	8000	8000	8700	6600	---	---	---

*tonnes per hectare was determined from the tonnes per acre yield by multiplying by 2.47.

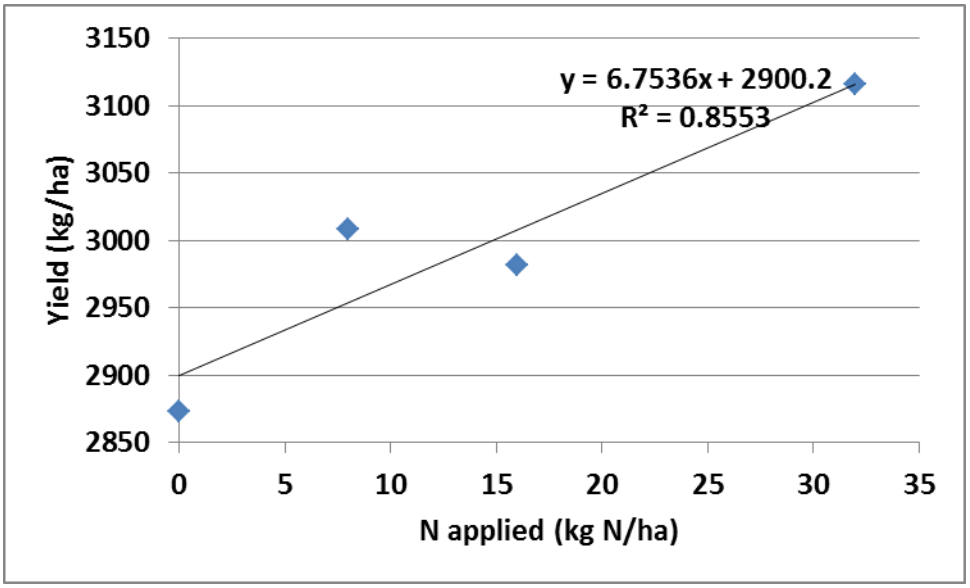

Figure 1. Rate of N application as Nutri-wave on yield of the oat cultivars.

Table 3. Yield and bushel weights from the 2016 and 2017 growing seasons and combined analysis.

	Yield Kg/ha			Bushel Wt (lbs/Avery bu)		
	2016	**2017**	**Combined**	**2016**	**2017**	**Combined**
Cultivar (Cv)						
Nova	2159	2792	2484	40.9	39.1	39.7
Nicholas	2893	3442	3134	38.6	36.4	37.3
Kara	2800	3382	3153	40.0	38.7	39.2
Rigodon	2503	3173	2870	39.0	37.8	38.3
Canmore	2480	3267	2903	40.5	39.3	39.8
Navaro	885.8	1111	906.8	46.3	46.2	46.6
Orrin	2593	3585	3183	38.3	38.4	38.6
Common	2487	3206	2861	39.0	36.9	37.6
Mean	2350	2995	2687	40.3	39.1	39.7
SEM	166.9	76.5	59.05	0.42	0.12	0.13
LSD	479.5	219.8	169.7	1.22	0.35	0.38
F Prob.	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N Rate (kg/ha)						
0	----	2873	2552	---	39.1	39.6
8	2368	3008	2738	40.3	38.7	39.6
16	2339	2982	2733	39.8	39.2	39.6
32	2343	3116	2725	40.8	39.2	39.9
Mean	2350	2995	2687	40.3	39.1	39.7
SEM	102.2	54.1	118.9	0.26	0.09	0.14
LSD	306.6	162.3	356.7	0.78	0.27	0.42
F Prob.	NS*	0.021	NS	0.041	NS	NS
Lin	NS	0.004	NS	0.086	0.043	NS
quad	NS	NS	NS	0.058	NS	NS
N Rate X Cultivar						
F Prob.	**Ns**	NS	0.019	NS	NS	0.008
Lin N Rate X Cv	NS	NS	0.021	NS	0.041	0.003
Quad. N Rate X Cv	NS	NS	NS	NS	NS	NS

*NS= Non Significant at p=0.05.

Table 4. Ranking of the various oat cultivars for yield and bushel weight.

	Yield			Bushel Weight *		
Ranking	2016	2017	Combined	2016	2017	Combined
1	Nicholas	Orrin	Orrin	Navaro	Navaro	Navaro
2	Kara	Nicholas	Kara	Canmore	Canmore	Canmore
3	Orrin	Kara	Nicholas	Nova	Nova	Nova
4	Rigodon	Canmore	Canmore	***Kara***	***Kara***	***Kara***
5	Common	Common	Rigodon	***Orrin***	***Orrin***	***Orrin***
6	Canmore	Rigodon	Common	**Rigodon**	**Rigodon**	**Rigodon**
7	Nova	Nova	Nova	**Common**	**Common**	**Common**
8	Navaro	Navaro	Navaro	**Nicholas**	**Nicholas**	**Nicholas**

*Cultivars that are bolded do not meet criteria for bushel weight for Grain Millers based on Winchester Bushel: Avery bushel *0.969. Kara and Orrin are on the recommended list for grain millers but are just short of their specification for Winchester bushel weight.

Table 5. Effect of cultivar and N rate on 1000 kernel weight in 2016, 2017 and for the combined analysis and plant height and harvest date in 2017.

	1000 K Weight (g)			2017	
	2016	2017	Combined	Height (cm)	Harvest Date within Month of July
Cultivar (Cv)					
Nova	30.8	34.78	33.15	94.81	17.0
Nicholas	33.2	36.32	34.83	88.38	22.0
Kara	37.1	40.89	39.27	79.31	18.0
Rigodon	38.7	38.19	37.87	94.56	19.5
Canmore	37.1	43.1	40.68	95.31	17.6
Navaro	27.9	31.62	30.02	81.50	23.0
Orrin	37.2	41.72	39.92	88.75	19.0
Common	35.3	42.33	39.62	104.8	13.0
Grand Mean	34.7	38.62	36.92	90.93	18.65
SEM	0.43	0.2299	0.2663	1.055	0.07
LSD	1.23	0.6606	0.7653	3.033	0.18
upper	35.0	38.95	37.3	92.45	18.65
lower	34.3	38.29	36.54	89.42	18.65
F Prob.	<0.001	<0.001	<0.001	<0.001	0.001
N Rate (kg/ha)					
0		38.5	36.8	88.5	18.8
8	35.0	38.7	37.0	91.1	18.8
16	34.6	38.8	37.0	91.8	18.6
32	34.4	38.5	36.8	92.3	18.5
Grand Mean	34.7	38.62	36.9	90.9	18.65
SEM	0.26	0.1626	0.19	0.74	0.05
LSD	0.78	0.49	0.57	2.22	0.13
F Prob.	NS*	NS	NS	0.002	0.001
Lin	NS	NS	NS	<0.001	0.001
quad	NS	NS	NS	0.059	NS
N Rate X Cv					
F Prob.	NS	NS	0.005	NS	0.001
Lin N Rate X Cv	NS	NS	0.018	NS	0.001
Quad N Rate X Cv	NS	NS	NS	NS	NS

*NS= Non Significant at p=0.05

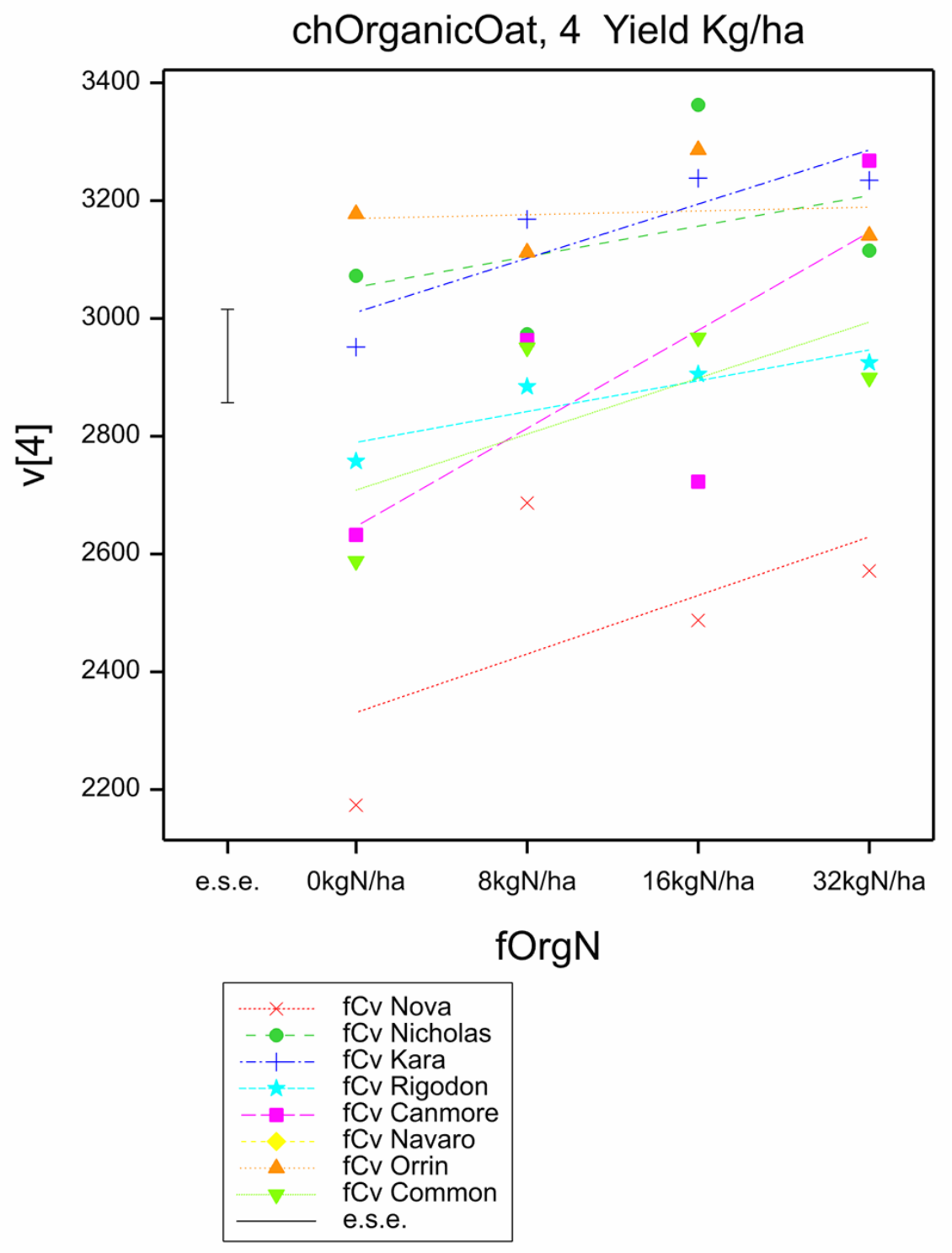

Figure 2. Interaction between the amount of N applied as Nutri-wave on grain yield of various oat cultivars when the two years were combined.

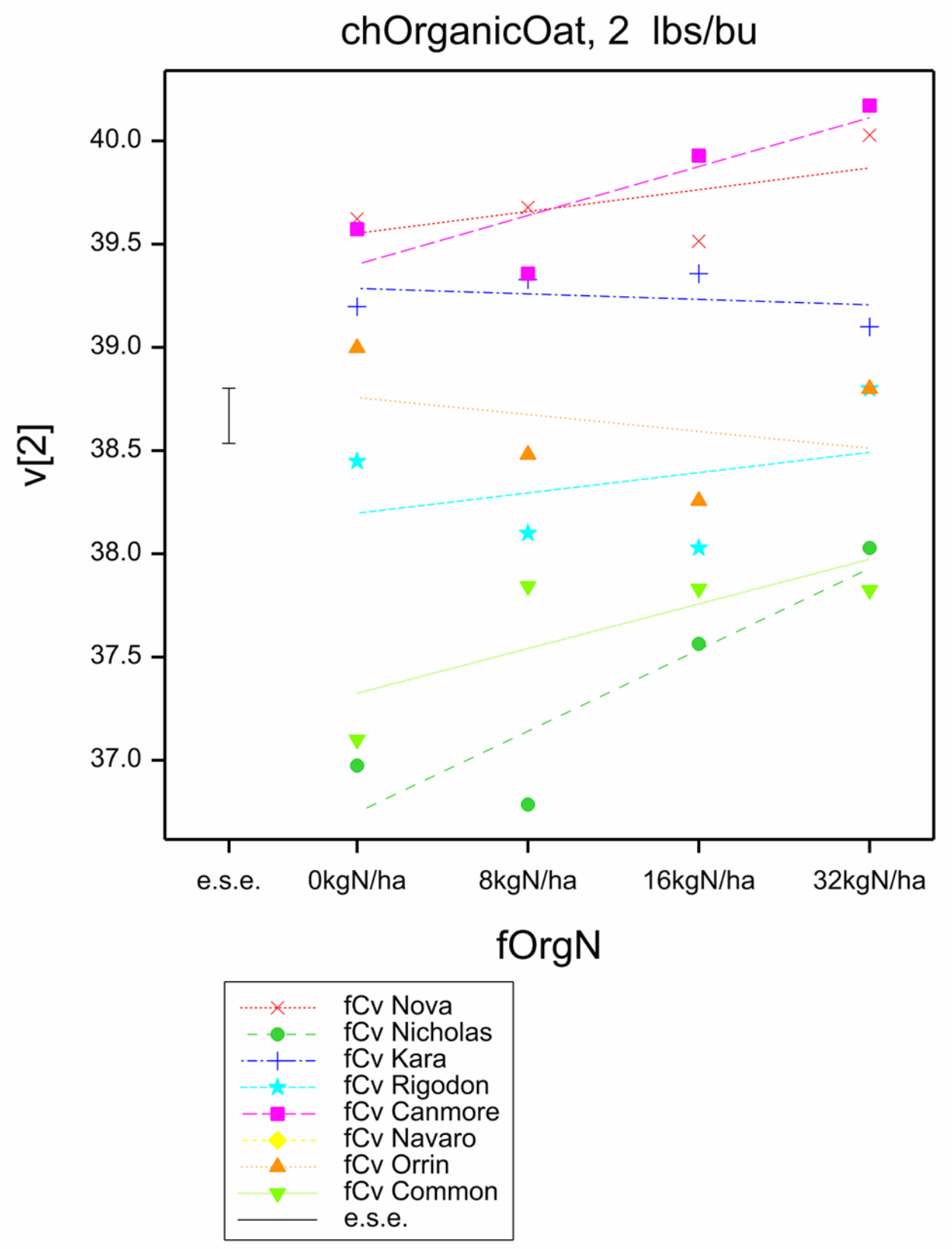

Figure 3. Interaction between cultivars and amount of N applied as Nutri-wave on bushel weight of oats.

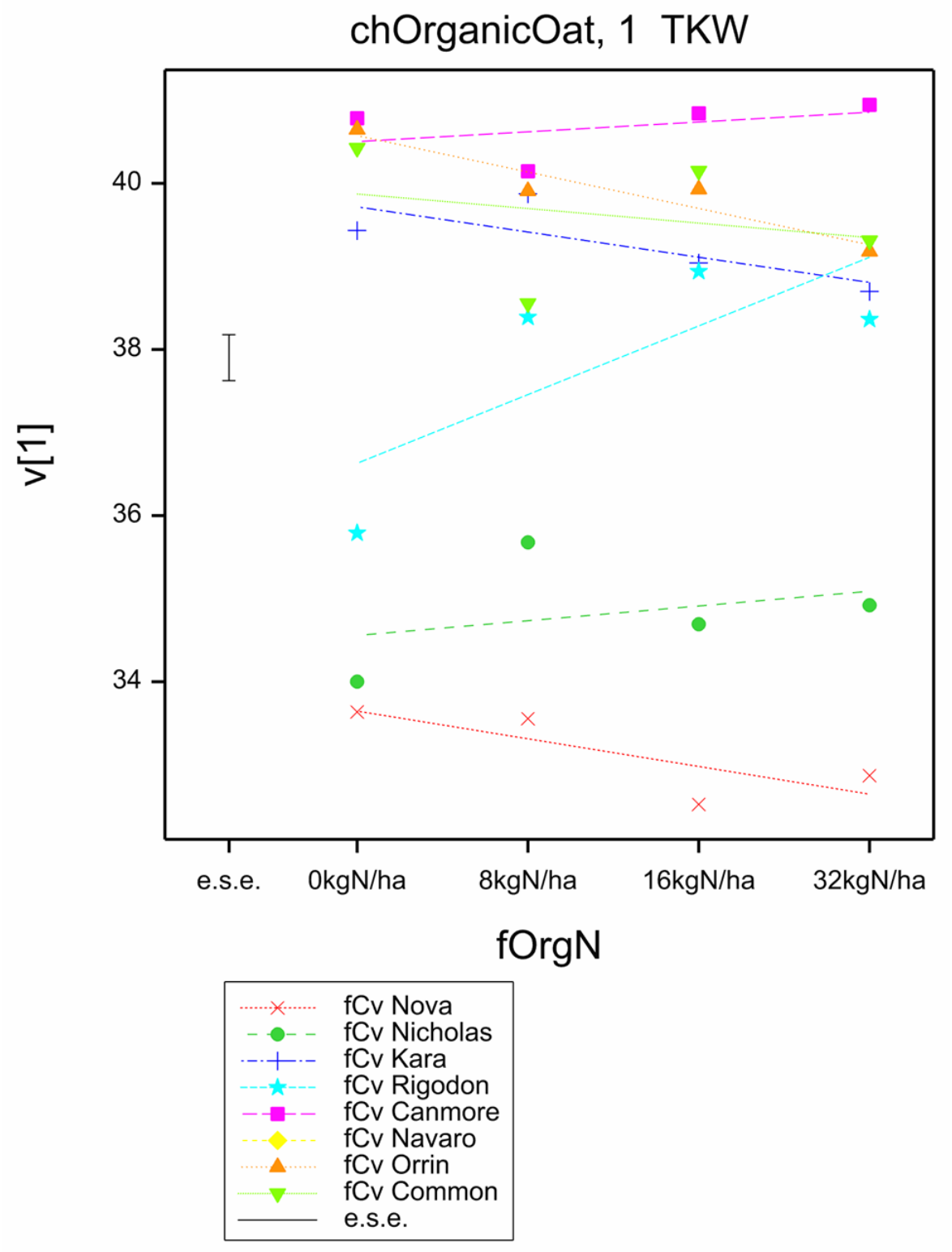

Figure 4. Interaction between cultivars and amount of N applied as Nutri-wave on 1000 kernel weight of oats.

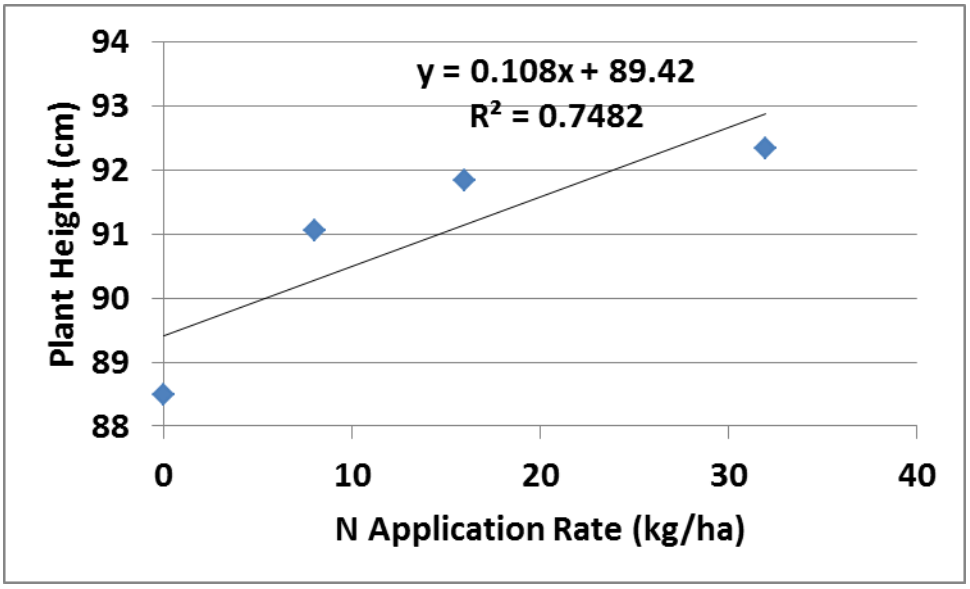

Figure 5. Effect of N application rate as Nutri-wave on height of oat cultivars.

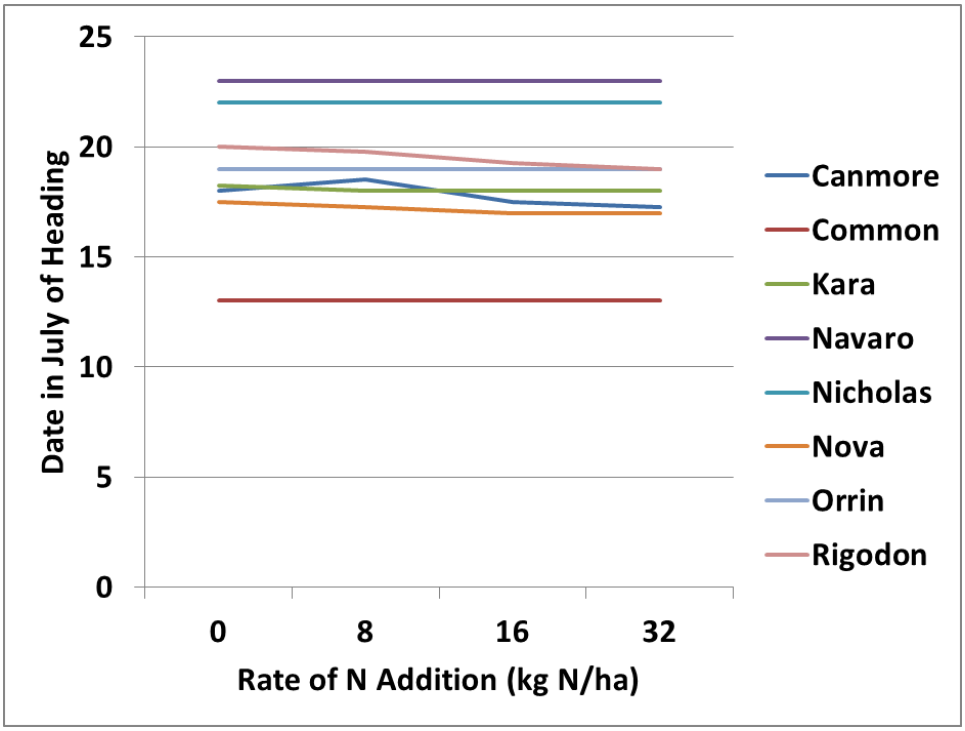

Figure 6. Effect of N application rate as Nutri-wave on date of heading in July of oat cultivars.