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Growth and Yield Variability of Corn (*Zea mays*), Carrot (*Daucus carota*), Peas (*Pisum sativum*) and Potatoes (*Solanum tuberosum*) Grown in Fallow and Unfallow Standoff Alberta Community Garden Soils

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Abstract

An experiment was conducted in the Standoff Alberta community garden over the 2019 summer time. Fallow and unfallow soils of Standoff community were used for this experiment. The major nutrients Nitrogen (N) was deficient and Phosphorus (P) was low in the unfallow soil. Furthermore, fallow soil N nutrient was low and optimum for P. Soil potassium was in excess for both soils. The pH of the soils were 7.4 and 7.5 in fallow soil and unfallow soil, respectively. One level of fertilizer application rate was applied to fallow and unfallow soils. Corn, carrots and peas were planted to unfallows soil while potatoes plants were cultivated to fallow soil. Standard agronomic practices were followed to establish this experiment. The six plants were taken per square meter bi-weekly in all the locations randomly across the field in zigzag pattern for growth parameters while six plants for corn, 2 plants for peas, carrots and potatoes per square meter were harvested for yield parameters. The means of growth and yield data collected from each location were subjected to a simple t-test so as to compare the performance of crops planted in each location. The results obtained showed that there were differences of growth in different locations across the field. Moreover, heterogeneous nature of the soil in different locations influenced soil nutrients ability to favour yield of corn, carrots, peas and potatoes. However, in all the 6 locations on the field, peas pod numbers at week 4, potatoes tuber number at week 5, peas dry weight at week 4 and carrot dry weight at week 5 were insignificant, all look the same. These results suggest that application of fertilizers and shortage of water were not evenly distributed which lead to uneven yield in different locations across the field.

Keywords: fallow soil, unfallow soil, corn, carrot, peas, potatoes

1. Introduction

Global warming has caused a lot of devastation to the earth. It has pushed the world beyond the economic threshold, thereby resulting to shortage of food. According to Food and Agriculture Organization of the united nations (FAO, 2002) defined food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" Food security in our community secures food from being lost. Production of food by establishing community garden could help food supply and adequate food nutrition to our community. Standoff, Alberta is a first nations, Kainai Blood Tribe community, we established a community garden to feed the community due to food shortage and expensive food price in the community. We grew common food crops that people in that area always consumed. Corn, carrots, peas and potatoes are stable food that most people in Standoff area consumed. Global warming has affected the production of these crops due to fluctuation in temperature and precipitation (Tubiello et al., 2007). Furthermore, soil degradation as a result of climate change contributed to the unstable soil fertility in this area, there is deficiency of macro and micro nutrients leading to crop failure or low yield of crops. Crop yield could be boosted by fertilizer application, which can have effect on CO_2 concentration in the atmosphere (Lobell & Field, 2008). Planting different crops (intercrop/mixed cropping) in the community garden offers great opportunity for crop diversity. The demand for corn (*Zea mays*) is increasing due to nutritional contents to human and animal feeds. Corn needs good quality soils with adequate soil moisture, nutrients such as nitrogen, phosphorus and potassium to germinate (Cox, 2010). Maximum yield can be achieved through good environmental condition as well as soil and seed quality. Carrot (*Daucus carota*) is a cool season crop, it has high carotene content and rich in calcium, phosphorus, folic acid and vitamin B. Carrot performed well under well moisture contents. Germination, growth and yield of carrot could be supported by application of 70-100 kg/ha N, 30-50 kg/ha P_2O_5, 55 kg/ha K_2O (Fordham & Biggs, 1985). However, there is reduction in propagation of carrot due to lack of high yielding varieties, disease and pest and soil salinity (Achakzai, 2012). Peas (*Pisum sativum*) is a leguminous crop. Pea is rich in nutrients for human diet and it supplies nitrogen to the soils. It is commonly used for vegetable, food and animal fodder (Schroeder et al., 1993; Murtaza et al., 2007). Potato is a root crop and 4th largest crop produced in the world after rice, wheat and maize (Chakraborty et al., 2010). Potato can be consumed as vegetable and as a main meal. The decline in production of potatoes has been affected by varieties, temperature, precipitation, soil fertility and carbon dioxide (Dalla Costa et al., 1997). Under the standard agronomical practice, corn yield 5 to 10 tons per hectare (Elizabeth Lunik,2015), carrot yield 20 to 30 tons per hectare (NC State Extension Publication, 1998), fresh yield of peas in pod vary from 3 to 10 tons per hectare (NDSU, 2016) and potatoes yield 10 tons per hectares (Canadian Potato Production, 2012).

Therefore, this current study attempt to study growth and yield variability of corn, carrot, peas and potatoes in reserved Kainai Blood Tribe (KBT), Standoff, Alberta soils. The main objective of this study was to examining soil variability (homogenous and heterogeneous nature of the soil) that could favour growth and yield of corn, carrot, peas and potatoes crops influenced by the same application of nitrogen, phosphorus, potassium and sulphate fertilizer to fallow and unfallow soils.

2. Materials and Methods

The experiment was conducted in Standoff Alberta community garden. Standoff is a first nations Kainai Blood Tribe (KBT) reserved community. It is located on latitude 49^o North and longitude 113^o West. Its location is on Hwy 2, 43 km South West of Lethbridge. The annual average temperature and rainfall are -1 to 12 ^{o}C and 515 mm, respectively. Standoff soil is a Brown Chernozemic soils that are found in the Southern part of Alberta. Soil samples were taken for physic-chemical analysis (Table 1). The experimental plots were cleared and one level of Urea (46-0-0), Mono ammonium phosphate (11-52-0), Potassium chloride or potash (0-0-60) and Ammonium sulphate (20-0-0-24S) were applied at 250 kg/ha, 392.47 kg/ha, 175 kg/ha, 250 kg/ha, respectively. The fertilizers applied were broadcasted and planting of crops were done on May 29, 2019 to 1.2 ha of unfallow soil cropped with 0.63 ha (22 rows of Navajo corn variety at rate of 2.27 kg), 0.14 ha of dominion carrots variety (5 rows at rate of 0.23 kg), 0.43 ha of Lincoln peas variety (15 rows at rate of 3.63 kg) and fallow soil was cropped with 0.81 ha of sangre potatoes variety at rate of 907.2 kg. The soil in corn plot was treated with 10 kg of urea fertilizer at 4 weeks of growth, when symptom of nitrogen deficiency appeared in the plot. The six plants were taken per square meter randomly across the field in zigzag pattern bi weekly in all the locations for growth parameters while six plants for corm, 2 plants for peas, carrots and potatoes were harvested for yield parameters. The six plants samples were taken for corn because three cobs were harvested per stand. The parameters measured were plant height/vinelenght measured with ruler, counting of leaves, number of branches, number of pods, weight of pod (g), number of peas, number of peas seeds, number of ears (corn cobs), ears weight, carrot length and diameter, carrot number, carrot weight, potato numbers and weight, plant fresh and dry weight (biomass production). The fresh plants were dried in the oven at 60 ^{o}C for 48 hours to obtain dry matter production or biomass production. The mean data of growth and yield parameters were subjected to one sample t-test to compare plant growth and yield parameters in different soil locations with the fertilizer applied using SPSS Statistical software. Standard error mean and significant at 2 tailed (0.05%) were also calculated.

3. Results

3.1 Plant Growth

Table 1 shows physic-chemical analysis of the soils used in this experiment. The major essential nutrients Nitrogen (N) was deficient and Phosphorus (P) was low in the unfallow soil. Moreover, fallow soil N nutrient was low and optimum for P. Soil potassium was in excess for both soils. Secondary nutrients such as Calcium (Ca) and Magnesium (Mg) were optimum in both soils whereas Sulphur (S) was low in both soils. Micro nutrients such as Zinc (Zn), Boron (B), Copper (Cu) and Sodium (Na) were low in both soils while soil Iron (Fe) was excess and Manganese was optimum in both soils. The pH of the soils were 7.4 and 7.5 in fallow and unfallow soils, respectively.

Table 1. Physic-chemical properties of fallow and unfallow soil in reserved Standoff community garden

Properties	Soil 1 (Unfallow)	Soil 2 (Fallow)
N (kg/ha)	29.51	59.41
P (kg/ha)	24.03	68.40
K (kg/ha)	1780.8	2231.6
S (kg/ha)	8	31.34
Ca (ppm)	4835.33	4576
Mg (ppm)	597.78	680
Zn (ppm)	0.64	1.2
B (ppm)	0.76	1.0
Cu (ppm)	0.98	1.0
Fe (ppm)	17.90	19.7
Mn (ppm)	6.76	6.70
Na (ppm)	13.84	27.6
OM (ppm)	5.19	5.50
pH	7.4	7.5
EC	0.456	0.5
Saturated Bases (%)		
Ca	77.36	73.40
K	6.57	8.2
Mg	15.87	18.0
Na	0.19	0.4
ECEC	31.14	31.10
K/Mg	0.42	0.45
Sand %	19.9	19.9
Silt %	42.1	42.1
Clay %	38.0	38.0
Textural class	Silty clay loam	Silty clay loam

Table 2a shows that corn height in all locations were not the same. Soils in location 2 and 5 in week 1, location 4 soil in week 2, location 5 soil in week 3, location 4 soil in week 4 and location 1 soil in week 5 supported the tallest high of corn plants. Furthermore, Table 2b shows that peas vinelenght were significantly higher in location 3 soil in weeks 1, location 6 soil in week 2, location 4 soil in week 3, location 3 soil in week 4 and location 4 soil in week 5 than other soil locations grown with peas. Moreover, in potatoes plot, Table 2c reveals that there was no significant difference in the potatoes plant height in week 1, all locations in term of fertilizer applied looked the same. However, soil in Location 4 had tallest potatoes height in week 2 than other locations while soil in location 5 favoured tallest height of potatoes than any other locations across the field for the rest of potatoes growth till harvest time. It is clearly obvious in Table 2d that soil in location 6 influenced tallest carrot plant height in week 2 than other locations, whereas soil in location 5 supported tallest carrot height in week 3, 4, and 5 than any other locations across the field.

Table 2a. Corn plant height in unfallow soil locations across the field over time

Location	Corn Height (cm)				
	WAP 1	WAP 2	WAP 3	WAP 4	WAP 5
Location 1	11	34	52.5	98.5	135.5
Location 2	11.5	28.7	68	108	124
Location 3	11	37.3	67.5	101.5	123
Location 4	10	44.5	72.5	106.5	130
Location 5	11.5	43	76.5	101	125.5
Location 6	10	35.5	60.5	90	106
SE	0.28	2.4	3.5	2.6	4.1
T-test	17.3	13.0	17.1	36.2	29.0
Sig(2-tailed)	**	**	**	**	**
N = 6					
Df = 5					

Table 2b. Peas vinelenght in unfallow soil locations across the field over time

Location	Peas Vinelenght (cm)				
	WAP1	WAP 2	WAP3	WAP4	WAP5
Location 1	14	22.5	47	60	49
Location 2	11	25	60	60	48
Location 3	16	14	57	72	51
Location 4	11	25.5	78	66	58
Location 5	10	26.5	61	60	50
Location 6	10	27.5	55	36	55
SE	1.0	2.0	4.2	5.0	1.6
t-test	6.0	8.7	12.8	10.6	29.02
Sig(2-tailed)	**	**	**	**	**
N = 6					
Df = 5					

Table 2c. Potato Plant height in fallow soil locations across the field over time

Location	Potatoes Height (cm)				
	WAP1	WAP2	WAP3	WAP4	WAP5
Location 1	4	28	40	45	54
Location 2	9	30	37.5	40.5	43
Location 3	7	21.5	36.5	29.5	34
Location 4	10	33.5	43.5	48	58
Location 5	7	26	47	50.5	60
Location 6	9	22.5	35.5	32.5	44
SE	0.88	1.9	1.8	3.5	4.1
t-test	1.90	11.3	18.6	10.1	10.4
Sig(2-tailed)	NS	**	**	**	**
N = 6					
Df = 5					

Table 2d. Carrot plant height in unfallow soil locations across the field over time

Location	Carrot Height (cm)			
	WAP2	WAP3	WAP4	WAP5
Location 1	7.8	14.5	10	32
Location 2	10	13.5	19.5	39
Location 3	10.5	14	15.5	33
Location 4	8.5	14.5	19.5	36.5
Location 5	6	16.5	21	39
Location 6	12.5	14.5	13.5	27
SE	0.93	0.42	1.7	1.9
t-test	3.5	20.6	6.1	14.9
Sig(2-tailed)	**	**	**	**
N = 6				
Df = 5				

Table 3a shows that location 3 soil supported corn leaves growth in week 1. Thereafter at week 2, there were no significant differences in all the locations to support corn leaves growth, which means that locations were homogenous. Nevertheless, Location 3, 5 and 6 soils jointly supported luxuriant leaves growth in week 3. Beyond week 3, at week 4 and 5, soil locations 1 and 3 favoured leaves growth, respectively. It is quite obvious in Table 3b that location 5 produced greatest number of peas branches in week 1 than other locations. Subsequently, at week 2, there were no significant differences in all the locations. However, at week 3, location 6 soil had the highest branches than other locations while location 1 and 3 soils produced highest branches at week 4 and 5, respectively. Table 3c shows that there was no significant difference in the ability of nutrient applied to support number of potatoes branches. However, it is quite obvious that location 5 soil gave highest branches at week 3 to 5 except in week 3 that location 6 soil had the same branches with location 5 soil. Table 3d reveals that location 1 soil and location 6 soil produced highest number of carrot branches than other locations at week 1 and 6, respectively while location 5 soil had the highest number of carrot branches at week 5. There was no significant difference in all the locations at week 4.

Table 3a. Corn number of leaves in unfallow soil locations across the field over time

Location	Corn Number of leaves				
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
Location 1	4.0	5.5	7.5	10.0	10.0
Location 2	5.0	6.0	7.5	9.0	9.5
Location 3	5.5	6.0	8.0	8.5	10.5
Location 4	3.5	6.5	7.5	8.5	8.5
Location 5	5.0	6.0	8.0	8.5	8.5
Location 6	4.5	6.0	8.0	9.5	8.0
SE	0.3	0.13	0.11	0.26	0.4
t-test	-4.7	0	16.65	11.62	7.9
Sig(2-tailed)	**	NS	**	**	**
N = 6					
Df = 5					

Table 3b. Pea number of branches in unfallow soil locations across the field over time

Location	Peas No of Branches				
	WAP1	WAP2	WAP3	WAP4	WAP5
Location 1	3.5	4.5	16	50	24
Location 2	4	5.5	14	32	28
Location 3	5	4.5	19	30	29
Location 4	3	4.5	19	21	26
Location 5	7	8	19	18	24
Location 6	2	5	21	13	25
SE	0.71	0.56	1.0	5.4	0.86
t-test	-2.7	-1.2	11.6	4.0	23.4
Sig(2-tailed)	**	NS	**	**	**
N = 6					
Df = 5					

Table 3c. Potato number of branches in fallow soil locations across the field over time

Potatoes Plant Branches	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
Location 1	5.5	6	11	13	28
Location 2	5.5	7	7	7	12
Location 3	2	5.5	10	8.5	11
Location 4	6	10.5	9.5	12	17
Location 5	5	7	12.5	15.5	30
Location 6	6.6	8	12.5	9.5	12
SE	0.66	0.73	0.85	1.3	3.5
t-test	-1.4	1.8	5.2	3.8	3.5
Sig(2-tailed)	NS	NS	**	**	**
N = 6					
Df = 5					

Table 3d. Carrot number of branches in unfallow soil locations across the field over time

Carrot Branches	2 WAP	3 WAP	4 WAP	5 WAP
Location 1	5	4.5	7	28
Location 2	4.5	5.5	6.5	12
Location 3	3.5	4.5	7.5	11
Location 4	2.5	4.5	8	17
Location 5	1	5	11	30
Location 6	2.5	6	5.5	12
SE	0.6	0.26	0.77	3.5
t-test	-4.7	-3.9	2.1	3.5
Sig(2-tailed)	**	**	NS	**
N = 6				
Df = 5				

3.2 Plant Yield

It is clearly seen in Table 4a that soil location 2 and 4 gave highest pea number of pods than other locations in week 3 and 5, respectively. Data showed no significant difference at 4 weeks Furthermore, location 1 soil produced highest pea pods weight at week 1 and 2 than other locations while location 4 soil gave the highest pea pods weight than other locations at week 5 (Table 4a). Moreover, Table 4b shows location 2 soil, location 1 soil and location 4 soil produced highest pea plant fresh biomass than other locations at week 3, 4 and 5, respectively.

Nevertheless, location 2 and 4 favoured highest pea plant dry biomass than other locations at week 3 and 5, respectively while there was no significant difference at week 4 (Table 4b). It was quite obvious in Table 4c that location 5 soil gave the highest corn weight than other soil locations. It was also noticed that location 1 soil and location 4 soil had the greatest number of pea seeds per plant than any other locations at week 4 and 5, respectively (Table 4c).

Table 4a. Pea number of pods and pods weight in unfallow soil locations across the field over time

Location	Pea Number of Pods			Pea Pods Weight (g)		
	WAP3	WAP4	WAP5	3WAP	4WAP	5WAP
Location 1	2	23	17	3.27	66.28	58.0
Location 2	3	8	39	1.57	26.17	116
Location 3	2	12	29	1.33	45.48	93.3
Location 4	2	10	40	1.2	43.3	230
Location 5	1	6	21	1.3	40.08	108
Location 6	2	5	21	1.35	21.9	89
SE	0.26	2.7	4.0	0.32	6.5	24.3
t-test	-15.5	1.7	5.4	-13.4	5.4	4.5
Sig(2-tailed)	**	NS	**	**	**	**
N = 6						
Df = 5						

Table 4b. Pea fresh and dry biomass production in unfallow soil locations across the field over time

Location	Pea Fresh Plant Weight (g)			Pea Dry Plant Weight (g)		
	WAP3	WAP4	WAP5	WAP3	WAP4	WAP5
Location 1	54.55	117.67	55.3	9.87	26.97	13.86
Location 2	99.29	49.00	140.7	15.65	10.85	35.97
Location 3	78.12	82.32	102.2	13.34	18.52	19.21
Location 4	73.34	53.82	176.5	11.88	11.78	41.88
Location 5	62.5	32.75	83	10.99	7.71	20.62
Location 6	82.65	19.95	65.6	14.7	5.3	15.0
SE	6.4	14.5	19.1	0.91	3.3	4.8
t-test	10.8	3.7	5.1	7.4	2.3	3.9
Sig(2-tailed)	**	**	**	**	NS	**
N = 6						
Df = 5						

Table 4c. Pea number of seeds per plant and corn weight per 6 plants in unfallow soil locations across the field over time

Location	Pea number of seeds per plant		Corn Weight (g)/6 Plants
	WAP4	WAP5	WAP5
Location 1	75	98	1864.17
Location 2	26	154	1817.19
Location 3	44	155	1902.96
Location 4	49	307	1936.76
Location 5	51	158	2009.34
Location 6	27	213	1821.66
SE	7.4	29.3	30.10
t-test	5.3	6.0	62.6
Sig(2-tailed)	**	**	**
N = 6			
Df = 5			

Yield components of carrot in relation to carrot weight, length and diameter were greatly influenced by the soil in location 2 (Table 5a). Furthermore, all the soil locations supported carrot marketable yield except soil in location 1 whereas location 1 soil influenced unmarketable yield. Table 5a shows that location 4 soil significantly influenced carrot plant fresh weight while there was no difference found in dry weight at 5 week of harvest.

Table 5a. Carrot yield and yield components parameters in unfallow soil locations at 5 weeks after planting

Location	Carrot weight (g)	Length (cm)	Diameter (cm)	Marketable Yield	Unmarketable Yield	Number of carrot	Total Plant Fresh weight (g)	Total Plant Dry weight (g)
Location1	22.8	10	7.5	0	1	1	14.26	2.88
Location 2	91.63	22.5	12	1	0	1	42.3	9.5
Location 3	52.05	8.5	10	1	0	1	26.26	4.76
Location 4	75	25	11	1	0	1	28.45	11.41
Location 5	53.64	8.5	9	1	0	1	17.76	3.47
Location 6	19.15	20	6	1	0	1	6.42	1.23
SE	11.6	3.1	0.91	0.17	0.17	0.0	5.1	1.6
t-test	4.0	3.2	3.6	-31.0	-35.0	0.0	3.2	-0.28
Sig(2-tailed)	**	**	**	**	**	**	**	NS
N = 6								
Df = 5								

Data 5b Shows that soil in location 5 favoured highest potato weight than other locations at week 5 of harvest while location 4 soil influenced potato diameter. There was no significant difference in number of potatoes harvested throughout the locations across the field. However, location 4 and 5 soils gave the awesomeness marketable yield (5 big tubers) while location 3, 4, 5 and 6 soils except location 1 and 2 soils gave unmarketable yield. Moreover, location 3, 4, 5 and 6 soils produced 2 small unmarketable tubers while location 1 and 2 soils produced 1 small unmarketable tuber. Location 5 soil produced highest plant fresh and dry weight biomass than any other locations (Table 5b).

Table 5b. Potato yield and yield components parameters in fallow soil locations at 5 weeks after planting

Location	Potato Weight (g)	Diameter (cm)	Marketable Yield	Unmarketable Yield	Number of potatoes/plant	Total fresh Weight (g)	Total Dry Weight (g)
Location 1	208.8	14.5	2	1	3	265.16	37.19
Location 2	259.9	15	3	1	4	97.7	16.45
Location 3	152.7	13.5	2	2	4	184.66	22.4
Location 4	499.7	15.5	5	2	7	206.5	32.24
Location 5	623.66	15	5	2	7	295.09	44.8
Location 6	370.7	14.5	4	2	6	166.1	27.87
SE	74.1	14.7	0.56	0.21	0.70	29.0	13.44
t-test	4.7	31.1	-4.4	-20.6	-1.2	6.8	5.8
Sig(2-tailed)	**	**	**	**	NS	**	**
N = 6							
Df = 5							

Note. Sig: Significant; *: significant difference (p = 0.05); **: highly significant difference (p = 0.01); SE: Standard Error; NS: Non significant; N: Total number of sample; Df: Degree of freedom; WAP: Weeks after planting.

4. Discussion

It is clearly seen from Table 1 that fallow soil contains more nutrients that unfallow soils, although both soils were deficient in macro nutrients such as nitrogen and phosphorus, optimum nutrient level of potassium. Fallow soil was cropped with potatoes while unfallow soil was cropped with corn, carrots and peas.

The ability of soil to support plant height in different locations of the field were not the same due to heterogeneous nature of the soil in different locations across the field. However, the soils were insignificant in potatoes plot in the first week due to lack of water or shortage of water supply to the plot. It could also be due to high temperature that facilitate evapotranspiration. Water supply is the one of the requirement for plant growth. It was confirmed that a stable water supply (homogeneity of water supply) can promote plant root systems to absorb water more efficiently and thus grow larger plants (Novoplansky and Goldberg, 2001; Hagiwara et al., 2012, Yu et al. 2019).

Nevertheless, it was observed that soils were homogenous at week 2, this indicates no differences in growth. This may be due to lack of nutrient uptake by the plants and/or inadequate application of essential nutrient such as nitrogen. Inadequate homogenous application of fertilizer caused the leaves of the corn to turn pale yellow which pave way for addition of urea fertilizer. Yu et al. (2019) confirmed relative nutrient concentrations in different soil areas (soil nutrient heterogeneity) can determine the extent to which plants concentrate more nutrient-absorbing organs in areas where nutrients are high. There is always increase in biomass shoot and root system in the location of the soil that contains high nutrients (Gersani et al., 1998; Fransen et al., 2001; Day et al., 2003b). Therefore, adequate homogenous application of fertilizer could able to support plant growth,

All the locations were significantly influenced by the applied fertilizer, soil in different locations support pea plants growth differently except at week 2. There was water shortage that could release the nutrient applied to support production of branches at first and second week of growth. Beyond this period water was made available to the plant to influence nutrient uptake that could support plant growth (Jackson & Caldwell, 1993; Gross et al., 1995; Ryel et al., 1996; Farley & Fitter, 1999).

It was revealed from Table 5a and b that heterogeneous nature of the soil influenced soil ability to favoured yield of corn, carrot, peas and potatoes in different locations. Soil fertility status is different in different locations. However, in all the 6 locations on the field, pea number of pods at week 4, number of potato tubers at week 5, pea dry weight at week 4 and carrot dry weight at week 5 were insignificant, all look the same. These may be due to water shortage and predominant high temperature in Southern Alberta this year (Tubiello et al., 2007). The results of Yu et al (2019) on Bolboschoenus plants also supported some plant varieties accumulate greater biomass and yield under heterogeneous conditions than under homogeneous conditions, given the same level of available concentration of nutrients. Both fallow and unfallow soils influenced heterogeneous soil nutrients availability in different area (locations) under the same rate of fertilizer application (Hutchings & Wijesinghe, 2008; García-Palacios et al., 2011).

5. Conclusion

We discovered that corn, carrot and pea crops planted in the fallow soil and potato crops planted in unfallow crop under the same treatment of fertilizer application showed heterogeneous nature of soil that influence more growth and yield of these crops in certain location than other locations. This is due to higher concentration of nutrients in one location than other location. Our goal is to achieve homogenous adequate application of fertilizer whereas some of our results showed inadequate application of fertilizer in homogenous status. Therefore, we need to apply adequate homogenous rate of fertilizer application to favour plant growth and yield so as to feed our community with healthy and nutritious food.

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