

Comparison of Tape Drip Irrigation and Furrow Irrigation Systems on Base of Water Use Efficiency and Yield of Potato in West of Iran

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Abstract

Potato is a major crop of Kermanshah province but shortage of water is important its production. To investigate yield and water use efficiency (WUE) of potato with trickle (T-Tape) and furrow irrigations, an experiment was performed in Kermanshah agriculture university research farm in 2007. The experiment was in complete randomized blocks design with 3 levels of irrigation-water amount (50%, 75% and 100% of cumulative evaporation from Class A pan) and irrigation methods (tape and furrow irrigations) with 3 replications. The results indicated that regardless to irrigation method, the maximum yield of potato (34.455 ton/ha) was achieved in irrigation water treatment of 100% and the minimum yield of potato (19.168 ton/ha) was achieved in irrigation water treatment of 50%. The effect of irrigation method on WUE was significant ($P < 0.01$). The highest WUE (3.93 kg/m³) was belonged to 50% tape irrigation and the lowest WUE (1.2 kg/m³) was belonged to furrow irrigation. Tape irrigation caused an increase of 66% in WUE as compared to furrow irrigation. The difference in WUE between 50%, 75% and 100% irrigation treatment was not significant. The least percent of tubers smaller than 35 mm (26.42%) was obtained in tape irrigation method with 50% irrigation-water amount and the highest percent of tubers smaller than 35 mm (37.99%) was obtained in furrow irrigation method. The highest amount of tuber production (37.17%) in marketable size (tubers larger than 55 mm) was obtained in tape irrigation method with 100% irrigation-water amount. As the irrigation water increased, percentage of tubers larger than 55 mm increased. The effect of irrigation method on dry matter was not significant, but with reduction of irrigation water, the specific gravity of tubers of potato was decreased. It is suggested to use tape irrigation method, with irrigation water amount of 100% for producing potato.

Keywords: type of irrigation, furrow irrigation, potatoes, dry

1. Introduction

Research has shown that potato plants are very sensitive to drought stress. Adverse effects of stress on growth and yield of potato plant growth stage, the gland is enlarged. At this stage, drought stress strongly influences the performance and product quality. Last growth stage of potato plants, is maturity (Almekinfers, 1991).

Gland, all existing simultaneously in one plant will not begin to accumulate dry matter. The differences caused by time and location of the tumor on the thyroid gland size and weight of the plant is to be Market-friendly, but the average tumor weight is less, reduced (Haverkort et al., 1990; Elizabet, 1992).

Yuan et al. (2003) effects of different irrigation regimes on potato crop growth in drip irrigation was investigated. The amount of irrigation water equal to 125, 100, 75, 50 and 25 percent of water evaporates from the surface of Chinese pan evaporation (pan diameter 0.2 m) was considered. Plant height, the amount of biomass, the whole lump of fresh products and Bazarpsnd glands (greater than 85 g) increased with increasing amount of irrigation water. Plant height and total product in the treatment of tumors close to 125% of evaporation from pan evaporation treatment was 100%. Irrigation water to increase the number of tubers did not increase, but will also

increase the average tumor weight. Irrigation water quantity and quality of tubers but reduced the tumor increases.

Shock et al. (1993) and Nadler and Heuer (1995) stated that reducing irrigation water, reduced tumor weight and reducing sugar level increases. This reduction in specific gravity of tubers in response to irrigation during the growing season is long.

The purpose of this study the effect of different amounts of irrigation water and irrigation methods on yield and groove type, yield components and properties of potato (dry matter and specific gravity) is.

2. Materials and Methods

Tested in the spring of 2007 in Kermanshah Agricultural Research Station in order to compare the performance of potatoes (variety Agria), furrow irrigation methods and types of performances. Silt clay soil with 54% clay and silt was 42%. Salinity of soil saturation extract ds / m 1.2 and soil PH 7.3, salinity of ds / m 1 and PH of 7.1 was measured. Tested in a randomized complete block design in three replications. Row distance 75 cm and 30 cm plant spacing and planting depth of 10 cm and a length of 13 m. Each treatment was planted with four rows. The drip irrigation emitters within the bladder tube type, was 30 cm. In this experiment, about 500 square meters of land with three replicates and based on a randomized complete block design was organized. The amount of irrigation water was considered as the main factor. 2 days away from drip irrigation and irrigation levels were 5 to 7 days. For this purpose, all the organs in the laboratory, isolated and dried in oven 70°C for 48 hours and then was weighed. Understanding plant response to treatments applied to the calculation of indicators, drawn and analyzed. SAS software was used for statistical analysis and was compared to Duncan. Measure and control the amount of irrigation water input to each plot in each treatment was done by volumetric meters. Gross irrigation requirements for the methods used in calculating the efficiency of the gully for 40 percent of the plots as runoff water was removed. Potato plant growth during the months of May, in October 1386 in the amount of evaporation from basin class A weather station located in Kermanshah city airport were measured. Given the location and circumstances surrounding the evaporation basin, basin coefficient of 0.8 was determined. For obtainfactor for the plant, the method was presented in the publication FAO24. This course is divided into 4 stages of plant growth. Crop coefficient for potato crop in this region in early, middle and end, respectively, 0.5, 1.15 and 0.6 were determined.

To calculate the crop water requirements of class A evaporation pan data for evaporation from the airport weather station that was located near the Faculty of Agriculture, was used. The potential evapotranspiration was calculated from the following equation:

$$ET = K_p \cdot E_{pan}$$

pan (1) Where: ET = evapotranspiration in millimeters between the two irrigation. Pan evaporation coefficient $K_p = E_{pan}$ = pan evaporation of water between every two consecutive terms of mm). The treated water is then multiplied by factors related to water level treatments (50, 75 and 100 percent) in evapotranspiration was calculated from a relationship.

All agricultural operations like weeding, fertilizing and spraying practices and require the same field experiment was conducted in each unit. At the end of the growing season of each experimental plot was 6 m length of two adjacent middle and potatoes were harvested. The smaller tumor size in groups of 35, 35 and 55 and older were divided into 55 mm.

For product quality testing Such as measuring specific gravity and percent dry matter samples taken from each treatment and was transported to the laboratory.

Table 1. Soil chemical features

Type of soil texture	Clay %	Silt %	Sand %	Zn Mg/kg	Fe Mg/kg	Mn Mg/kg	Carbon %	PPM Absorbable potassium	PPM Absorbable phosphor	EC ds/m	pH
Silty clay	45	42.3	3.7	1.36	11.9	7.8	1.38	440	26	1.2	7.3

Table 2. Water chemical features

SAR	Percent of soluble sodium	Sum of cations	Na ⁺	Mg ⁺⁺ + Ca ⁺⁺	Sum of anions	SO ₄ ⁻⁻ Meq/l	CL ⁻ Meq/l	HCO ₃ ⁻ Meq/l	CO ₃ ⁻⁻ Meq/l	pH	TDS Mg/lit	EC
0.54	11.7	9.23	1.08	8.15	9.23	1.18	1.9	6.15	0.0	7.1	640	1000

2.1 Use Efficiency

Application efficiency in furrow irrigation Used to calculate the efficiency of the samples before and after irrigation water is used in deep root development. Depth development of roots sampled from soil by digging a hole to reach 5 times with water.

Table 3. Applied yield in furrow irrigation

Time of irrigation	Soil humidity Average before irrigation %	Soil humidity Average after irrigation %	Root extension depth average (Centimeter)	Depth of water in furrow (Centimeter)	Applied yield %
1	14.9	24.7	20	6.14	49.48
2	14.8	23.4	20	6.51	40.95
3	14.8	24.6	20	7.9	38.45
4	15.2	24.1	20	8.09	34.10
5	15.1	25.1	20	7.42	41.78

As Table 3 can be used respectively at 34.1 and maximum efficiency is 49.48 percent. Major cause of low irrigation efficiency, losses in surface runoff is.

2.2 Use Efficiency in Irrigation Type

The first type of method used to measure the efficiency of uniform and then calculate the coefficient of TR, the efficiency was achieved. The uniformity coefficient, flow rate 36 outputs (4 outputs each type, 3 sub-pipes of 3 replicates) were also measured. Uniformity coefficient of 0.89 and efficiency with regard to application of 0.9 = TR, 0.80, respectively.

Table 4. Applied yield in tape drip irrigation

Ea	TR	EU	qa Liter per hour	qn Liter per hour
0.80	0.90	0.89	1.222	1.083

qn = average flow of a quarter-liter h;

qa = average flow rate measured by output, liter per hour;

EU = uniformity based on measurements of water leaving the farm, the percentage;

TR = the ratio of transpiration to;

Ea = Application efficiency.

Specific gravity divided by the weight of tumor samples on the sample size was achieved. For tuber dry matter are randomly selected and their skin was shaved and the mixture was chopped very fine.

About 5 grams of this mixture in the Chinese plant in Avon 105 C to constant weight had been dropped and 6 hours Airflow in the oven until constant weight was reached. The Chinese plant was cooled in desiccator and weigh again, and dry matter percentage was calculated (Van Heemst, 1986).

Volume of water used in irrigation water in different treatments (Table 5) are presented.

Table 5. Total volume of water the plant during each irrigation methods

Treatment	00% Water requirement	75%Water requirement	50%Water requirement	Furrow irrigation
Total water (per hectarem)	9749.62	7312.21	4874.81	21357.20

Comparison of moisture in the onions under drip irrigation tape is said treatments to obtain samples. Weight around the stack of potatoes in three successive irrigation. Onions compared to moisture and humidity distribution. Irrigation treatments listed in the Surfer software was used for the graphs in Figure 1 is shown.

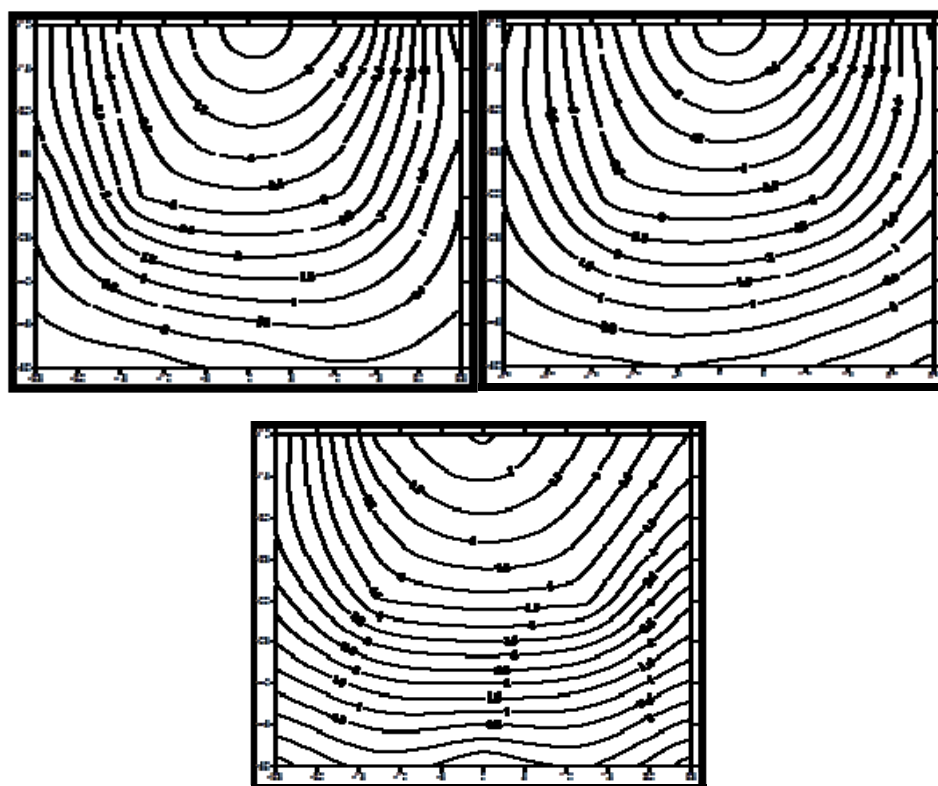


Figure 1. Chart moisture in irrigated onions first - (a) treatment by 50%, (b) treatment by 75% and (c) treated 100%

3. Results and Discussion

Moisture curves were plotted the gradient changes, lack of moisture in the bottom three were initially treated with Depth is too high. The lack of moisture in all three treatments in the upper layers of soil and Much of is located in the root density, the lower layers and with a greater depth humidity is low.

Table 6. Comparison of average performance and efficiency of water use

Treatment	Yield (Ton pre hectare)	Water use efficiency (kg/m ³)
50% evaporate from pan	19.16 c	3.93 a
75% evaporate from pan	25.93 b	3.54 a
100% evaporate from pan1	34.45 a	3.53 a

Two types of drip irrigation and crop yield in each groove being separated and were significantly different in Duncan.

Potato yield in drip irrigation method is 100 percent more performance than 8.873 ha. The method has been the product surface. Necessary to maintain moisture in the root zone of plants to absorb nutrients and tumor growth, analysis of water and water use efficiency is of particular importance.

In this test the water in the gully was more than twice as drip irrigation, however, per acre product is much lower.

3.1 The Tuber Yield

The amount of irrigation water on the tuber yield was significant at the 1 percent level (Table 7). The lowest 50 percent of the treatment of 19.168 tons per hectare and a maximum of about 100 percent of the 34.455 ha were treated (Table 7). 75% of surface irrigation treatment and Duncan groups were in a group. This experiment showed that the more water the plant will supply the tumor grows.

Table 7. ANOVA analysis of potato

Change source	Freedom degree	Yield of plant (kg)	Yield (ton per hac)
repetition	2	0.015	6.13
treatment	3	0.425**	354.02**
Error	6	0.036	27.60
total	11	0.477	387.76
Change coefficient		8.85	8.16

**Indicate a significant effect of experimental treatment is 1% probability level.

Table 8. compared with an average yield of potatoes

Treatment	Yield of plant (kg)	Yield (ton per hac)
50% evaporate from pan	0.62 c	c19.16
75% evaporate from pan	0.95 b	b25.93
100% evaporate from pan1	1.13 a	a34.45
Furrow irrigation	0.82 b	b25.58

The numbers in each column treatments with a common letter are not significantly different according to Duncan test at 5% level are likely.

3.2 Tumor Size

3.2.1 Percentage of Tubers Smaller than 35 mm

The amount of irrigation water on the percentage of tubers smaller than 35 mm were not significant (Table 9). Minimal lesions (26.47% of tiny glands) in the treatment of 100 percent drop, and most lesions (37.39 percent) was observed in surface irrigation.

3.2.2 Glands of 55-35 mm

The amount of irrigation water on the percentage of tubers smaller than 35 mm were not significant (Table -9). The classification of tumor size, size 55-35 mm seed size is considered. If the goal is the production of seed potatoes, seed tuber production of the highest drop of 50 percent (47.87 percent) are.

3.2.3 Percentage of Tubers Larger than 55 mm

The amount of irrigation water on the percentage of tubers smaller than 35 mm were not significant (Table -9). Tumors larger than 55 mm in size are considered edible and Bazarpsnd.

Table 9. Analysis of variance of the groups with tumor sizes smaller than 35, 55-35 and greater than 55 mm

Change source	Freedom degree	Smaller than 35 mm	Between 35-55 mm	larger than 35 mm
repetition	2	356.94	7.87	326.44
treatment	3	270.86	211.13	370.14
Error	6	388.61	505.60	274.83
total	11	1016.42	724.66	971.42
Change coefficient		26.26	22.31	23.981

**Indicate a significant effect of experimental treatment is 1% probability level.

Table 10. 1% of the mean tumor size in groups smaller than 35, 55-35 and greater than 55 mm

Treatment	Smaller than 35 mm	Between 35-55mm	Larger than 35 mm
50% evaporate from pan	26.42 a	47.87 a	25.70 ab
75% evaporate from pan	31.67 a	40.45 a	27.86 ab
100% evaporate from pan1	26.47 a	36.35 a	37.17 a
Furrow irrigation	37.99 a	39.85 a	22.15 b

The numbers in each column treatments with a common letter are not significantly different according to Duncan test at 5% level are likely.

3.3 The Number of Main Stems

The amount of irrigation water on the number of main stems per square meter and the plant was not significant (Table 11). The number of main stems per plant size and physiological age of seed tubers and genetic characteristics of the figure (the number of seed tubers) depends on (Nadler & Heuer, 1995). Maximum number of main stems per square meter in the treatment of 100% (25.08), respectively.

3.4 Total Tuber

3.4.1 The Number of Tubers Per Square Meter

The amount of irrigation water on the tubers was not significant (Table 11). The maximum number of tubers per square meter of treated water by 50% (35.86) and the minimum number of tubers per square meter of treated water by 75% (34.06) was obtained. Havrkvt and colleagues showed a high correlation between the number of tubers is ostolon (Haverkort et al., 1990).

Table 11. Analysis of variance of main stem and number of tubers

Change source	Freedom degree	Number of stem in each plant	Number of stem in m ²	Number of tuber in each plant	Number of tuber in m ²
repetition	2	2.50	54.62	2.23	45.93
treatment	3	2.56	63.04	1.86	44.93
Error	6	1.63	51.50	10.32	260.35
total	11	6.70	169.17	14.42	351.22
Change coefficient		12.25	13.73	19.29	19.30

**Indicate a significant effect of experimental treatment is 1% probability level.

Table 12. Comparison of average number of main stems and tubers

Treatment	Number of stem in each plant	Number of stem in m ²	Number of tuber in each plant	Number of tuber in m ²
50% evaporate from pan	4.03 a	19.75 a	7.09 a	35.86 a
75% evaporate from pan	4.19 ab	21.29 a	6.19 a	31.06 a
100% evaporate from pan1	5.02 a	25.08 a	6.71 a	33.90 a
Furrow irrigation	3.80 b	19.21 a	7.19 a	35.71 a

The numbers in each column treatments with a common letter are not significantly different according to Duncan test at 5% level are likely.

3.4.2 Percentage of Dry Matter

The amount of irrigation water on dry matter was not significant (Table 13). The percentage of dry matter decreased with increasing amount of irrigation water. Mohammadi Fayznya and grace and Fayznya Mousavi said that increasing the amount of irrigation, the percentage increase in dry matter (Elizabet, 1992; Haverkort et al., 1990).

3.5 Gland Density

The amount of irrigation water on tuber specific gravity was significant at the one percent level. Maximum density (1.11 grams per cubic centimeter), the type of treatment was 100%. Irrigation water increased with increasing specific gravity of tubers that are consistent with studies of Yuan et al.

Table 13. Analysis of variance and the density of dry matter

Change source	Freedom degree	Density (g/cm ³)	Dry matter %
repetition	2	0.000026	8.05
treatment	3	0.001296**	13.78
Error	6	0.000062	12.58
total	11	0.001384	34.43
Change coefficient		0.293083	6.97

**Indicate a significant effect of experimental treatment is 1% probability level.

Table 14. Comparison of average density and dry matter

Treatment	Density (g/cm ³)	Dry matter %
50% evaporate from pan	1.085 d	22.08 a
75% evaporate from pan	1.102 b	21.51 a
100% evaporate from pan1	1.113 a	19.46 a
Furrow irrigation	1.093 c	19.99 a

The numbers in each column treatments with a common letter are not significantly different according to Duncan test at 5% level are likely.

The type of irrigation compared with furrow irrigation, potato yield, water use efficiency and the percentage was higher in tumors larger than 55 mm seed is a factor of 0.75 is recommended.

In order to understand plant responses to treatments, growth was calculated, plotted and analyzed. In general, both surface and drip irrigation methods, parameters, leaf weight, stem weight, shoot dry weight, root weight and root dry weight is affected. In the fourth column from left to right, respectively, showed 50%, 75%, 100% irrigation treatment is superficial. But on the dry weight of leaves, number of stems per plant, number of tubers per plant, number of tubers larger than 35 mm and total weight of the gland has no effect. The effect of harvest date, except for number of stems

For this purpose, all the organs in the laboratory, isolated and dried in oven 70°C for 48 hours and then was weighed. In order to understand plant responses to treatments, growth was calculated, plotted and analyzed. In general, both surface and drip irrigation methods, parameters, leaf weight, stem weight, shoot dry weight, root weight and root dry weight is affected. In the fourth column from left to right, respectively, showed 50%, 75%, 100% irrigation treatment is superficial. But on the dry weight of leaves, number of stems per plant, number of tubers per plant, number of tubers larger than 35 mm and total weight of the gland has no effect. The effect of harvest date, except for number of stems per plant and number of tubers per plant was significant. With the view of some models, the growth characteristics include: Leaf weight ratio (LWR), Tuber dry matter (TDM), Leaf dry matter (LDM) and Total dry matter (TDM) during the growing period and calculated on the basis They plant growth were analyzed.

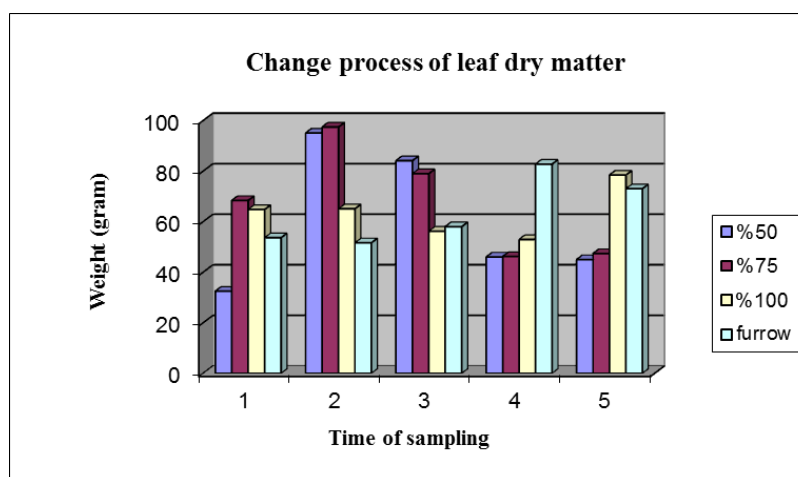


Figure 1. The changes process of traits

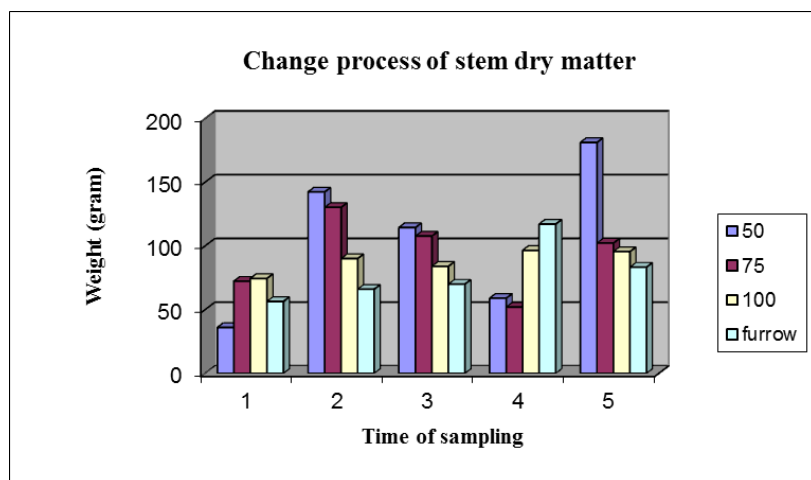


Figure 2. The changes process of traits

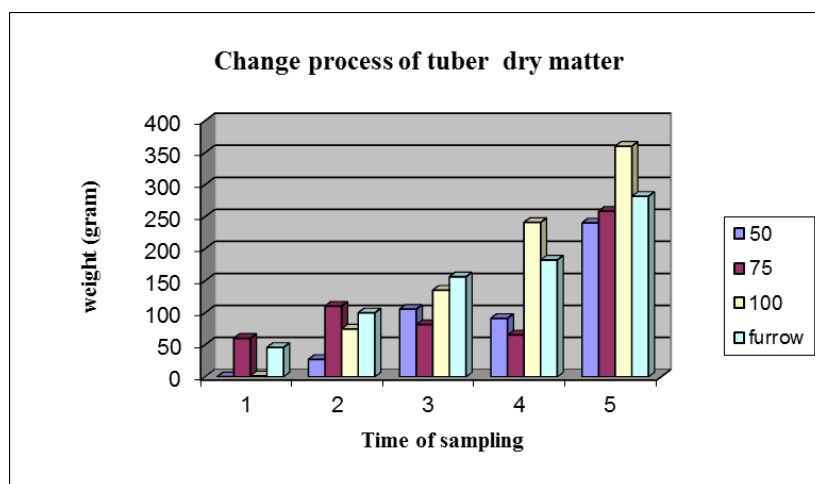


Figure 3. The changes process of traits

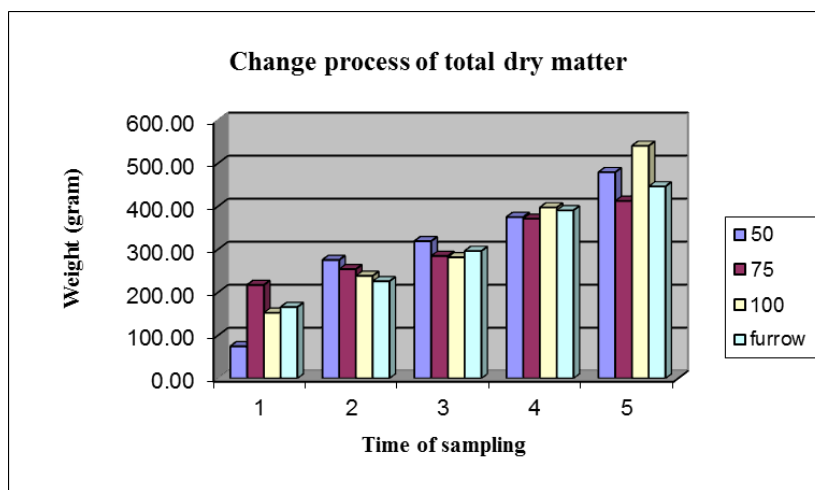


Figure 4. The changes process of traits

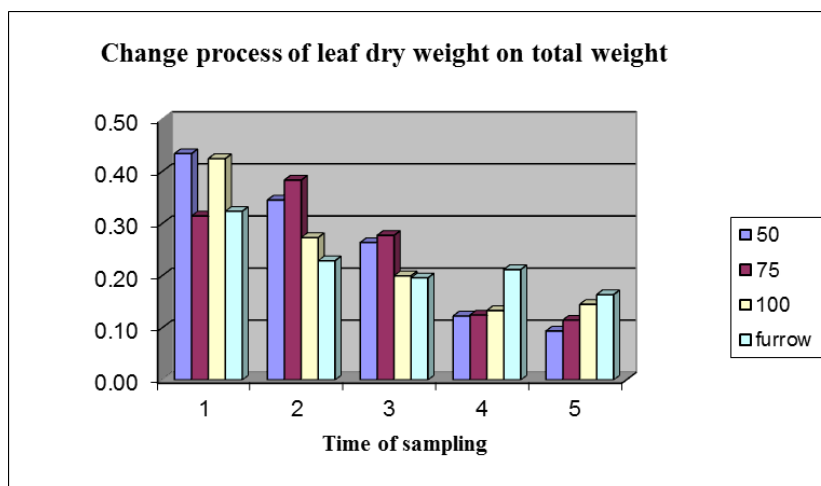


Figure 5. The changes process of traits

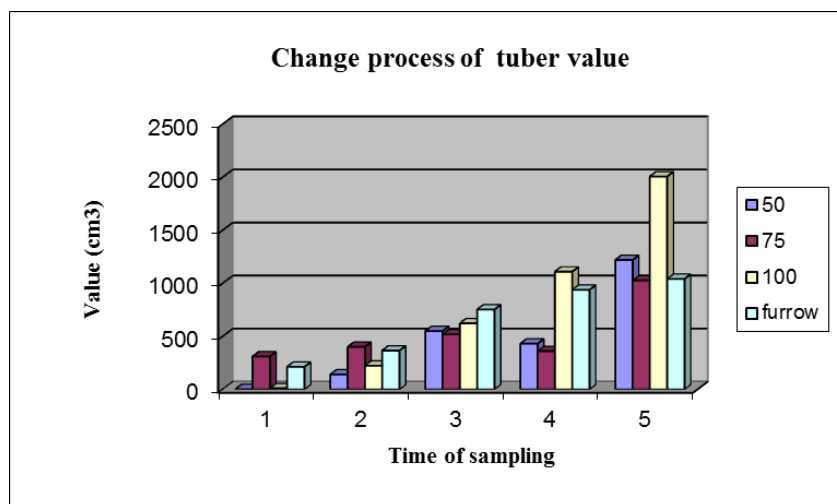


Figure 6. The changes process of traits

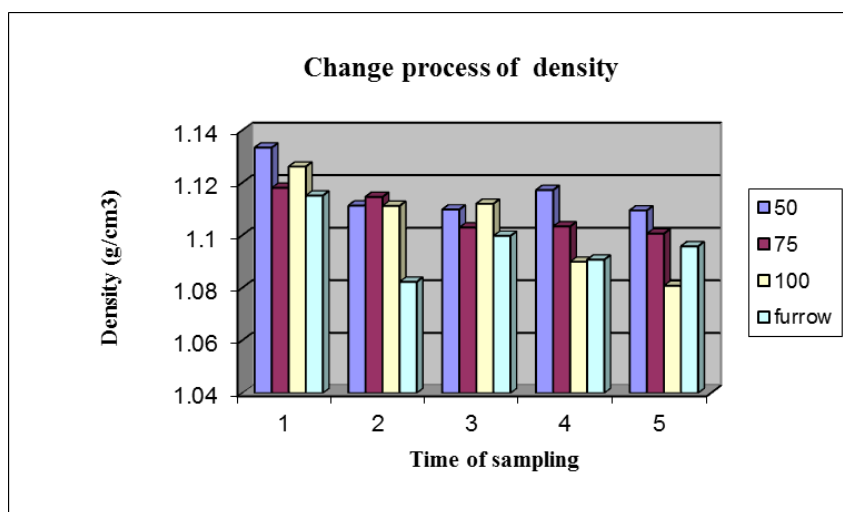


Figure 7. The changes process of traits

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