Effect of Helianthus Tuberosus Straw and Sheep Manure Ratio on Growth and Fruit Quality of Pepper

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Keywords: Fermented, Erusalem Artichoke Straw, Substrate Cultivation, Pepper, Quality and Yield.

Abstract: Helianthus tuberosus is an emerging economic crop that has developed rapidly in Northwest China in recent years. Its straw biomass is large, but its utilization rate is still low at present. To solve the problem of combined utilization, this paper carried out a study on the appropriate ratio of Helianthus tuberosus fermented stalks and sheep manure in the substrate cultivation of different varieties of pepper. The results showed that when the ratio of Helianthus tuberosus stalks to sheep manure is 1:3, the physical and chemical properties of two different pepper varieties, such as pH and aeration porosity, are better than the seedling substrate treatment within a reasonable range after 100 days of cultivation; the soluble sugar and vitamin C content of the two pepper fruits are significantly higher than the seedling substrate treatment, reaching 71.59mg/g and 102.95 mg/g, respectively; compared with the seedling substrate treatment, the yield of the two peppers increased by 3% and 5% respectively. Therefore, the suitable substrate ratio for pepper cultivation is: $V_{\text{Helianthus tuberosus straw}}$: $V_{\text{sheep manure}}$: $V_{\text{substrate soil}}$: V_{perlite}: $V_{\text{vermiculite}}$=1: 3: 3: 1: 1.

1 INTRODUCTION

Helianthus tuberosus (Helianthus tuberosus L.), a perennial herb with strong adaptability, has the characteristics of cold and drought resistance, barren tolerance, and strong stress resistance. It is an extensive plant (Wu, 2013; Xue, 2017). The above-ground stems and leaves of Helianthus tuberosus have high protein, sugar and other nutrients, and the biomass accounts for 40%-50% of the total plant (Li, 2011). Each hectare of Helianthus tuberosus tubers can produce 2~3t, and the yield of stems and leaves is8.7t (Xiang, 2019). At present, the research and development of Helianthus tuberosus is mainly concentrated on desertification of saline-alkali land (Lu, 2007), inulin content (Liu, 2016), biotechnology (Wang, 2004), feed value of stems and leaves (Yan, 2018), bioenergy (Liu, 2012), etc. It is the research on the underground tubers of Helianthus tuberosus, and there are few studies on the utilization of the above-ground stems and leaves (Ji, 2017).

Organic ecological soilless cultivation is a new type of crop cultivation mode that has developed rapidly in recent years. The use of solid fertilizer instead of nutrient solution greatly reduces the investment cost and has the characteristics of simplicity, practicality, and effectiveness. The substrate is mainly agricultural waste such as straw and animal manure, and the recycling of agricultural waste is also an important way to achieve sustainable agricultural development. Previous studies have concluded that the application of Helianthus tuberosus leaves into the soil has a certain inhibitory effect on the growth of weeds (Wang, 2018) and Helianthus tuberosus stalks are conducive to the growth of continuous cropping tomatoes and have a certain effect on root-knot nematode control (Song, 2013). Regarding the substrateization of crop stalks, Song's research (Tong, 2012) showed that the growth of tomatoes grown on a composite substrate of 100%

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Lou, X., Wei, X., Zhang, G., Li, Y. and Zhong, Q.
Effect of Helianthus Tuberosus Straw and Sheep Manure Ratio on Growth and Fruit Quality of Pepper.
DOI: 10.5220/0011224800003443
In *Proceedings of the 4th International Conference on Biomedical Engineering and Bioinformatics (ICBEB 2022)*, pages 514-522
ISBN: 978-989-758-595-1

rice straw, rice straw: rice husk=75V:25V performed better, and indicators such as stem thickness and number of leaves were significantly better than the control. And the yield has increased by 30%~33%; it shows that substrate cultivation can indeed increase the yield of peppers, tomatoes and other vegetables. The experiment of Tong (Fu, 2010) proved that the volume ratio 4:6 is the best among the different ratios of coal gangue and decomposed rape straw, and the plant height, fresh weight and number of leaves of vegetables such as cabbage and lettuce are all significant. Better than soil cultivation; Fu's (Liu, 2017) experiments proved that adding fermented corn stalks can improve the risk resistance of greenhouse pepper overwintering cultivation to a certain extent, and at the same time improve the quality of pepper to a certain extent, promote early maturity of pepper, and increase total output; Liu et al. found that the substitution amount of Helianthus tuberosus fermented straw for peat is best when adding 20%-40% to the substrate of peat and vermiculite (Li, 2003); Ji further refined the research on this basis and concluded When the addition of Helianthus tuberosus straw was 20%-30%, the vitamin C, soluble sugar content and sugar-acid ratio were significantly higher than the control. When the addition of Helianthus tuberosus straw was 20%, the yield increased by 14% (Ji, 2017). At present, there are many researches on Helianthus tuberosus stalks used in tomato planting, and there are few researches on pepper planting. However, through the above research, it can be seen that Helianthus tuberosus stalks have the potential to be used as a pepper cultivation substrate.

Animal manure is rich in organic matter and various nutrient elements required by crops, which is an important substrate component for organic ecological soilless cultivation. Sheep manure is a common material for substrate compounding. It has features such as large yield, easy availability and low cost in Qinghai. Therefore, in this experiment, Helianthus tuberosus straw was used as the research material, the fully fermented Helianthus tuberosus straw and sheep manure were mixed in different proportions, and $V_{\text{substrate soil}}$: $V_{\text{vermiculite}}$: V_{perlite}=3:1:1 was added to each treatment, then used as a pepper cultivation substrate. The trough-type soilless cultivation method is used to monitor the physical and chemical properties of the substrate and the growth of peppers, analyze and determine the physical and chemical properties of the composite substrate and the growth, quality, and yield of peppers, compare the differences between different ratios, and find suitable Qinghai The cultivation substrate for provincial pepper cultivation combines the resource utilization of agricultural waste with soilless cultivation, improves the utilization rate of Helianthus tuberosus stalks, promotes the development of Helianthus tuberosus and pepper industry, and provides a theoretical basis for promoting the development of circular agriculture.

2 MATERIALS AND METHODS

2.1 Materials

Helianthus tuberosus straw comes from the Horticultural Innovation Base of Qinghai Academy of Agriculture and Forestry Sciences. It was harvested on October 20, 2018 and crushed into small pieces of about 1 cm; the straw fermentation inoculum was selected from the straw degradation agent 008-J produced by Zhengzhou Yifuyuan Biotechnology Co., Ltd.; the inoculum was used Propagating at room temperature for 5-7 days, stirring every day; fermentation adopts indoor static high temperature and aerobic method, turning the pile and sprinkling water every 5 days to keep the moisture content at about 60%; the average indoor temperature is 6.3℃; the tested pepper varieties were Qinghai local variety "Ledu long pepper" and main variety "Hangjiao No. 8". The LED plant sterilization fill light used in the experiment was provided by Zhejiang Xiaoyang Agricultural High-tech Co., Ltd.

2.2 Experimental Design

The experiment was carried out in the plastic greenhouse of the Horticulture Innovation Base of the Academy of Agriculture and Forestry Sciences of Qinghai University. It adopted a completely randomized block design with a total of 5 treatments (see Table 1), among which the seedling substrate ($V_{\text{Substrate Soil}}$: V_{Perlite}: $V_{\text{Vermiculite}}$ = 3:1:1) as control group (CK), 3 repetitions, 2 test pepper varieties (P1 is "Ledu long pepper", P2 is "Hangjiao No.8"), a total of 30 plots with a plot area of 2.1m^2. The digging groove was used for cultivation, with a length of 300 cm, a width of 70 cm, a depth of 35 cm, and a groove spacing of 50 cm. The cultivation substrate was isolated by a plastic shed film. Double-row planting, single-stem pruning, plant spacing 30cm, and planting 20 plants per groove were adopted. On February 25, 2019, the pepper seeds were soaked and disinfected with 72-hole plastic plugs for sowing. The seedling substrate ratio was $V_{\text{Substrate soil}}$: V_{Perlite}: $V_{\text{Vermiculite}}$ = 3:1:1. When the pepper seedlings grow to 8 leaves of each core, and the seedling age is 55 days, healthy and healthy seedlings were chosen to be planted on April 20, and the integrated irrigation method of water and fertilizer was used for watering management, and irrigate the special nutrient solution for pepper prepared， then place an LED plant sterilization fill light 1m away from the top of the plant, 1 lamp / 10m^2 by the Academy of Agriculture and Forestry Sciences of Qinghai University. The physical properties of the substrate were measured at the time of planting and 100d after planting; the growth and quality indexes of pepper were measured at 60 days, 90 days and 120 days after planting. During the growth period of pepper, all other conditions were set as the same.

Table 1: The ratio of Helianthus tuberosus straw substrate (volume ratio).

Treated	Helianthus tuberosus straw	Sheep manure	Matrix soil	Perlite	Vermiculite
CK	-	-	3	1	1
Q1	2	2	3	1	1
Q2	3	1	3	1	1
Q3	1	3	3	1	1
Q4	-	2	3	1	1

2.3 Index Measurement and Method

2.3.1 Physical Properties of the Substrate

Refer to the method of Li (Guo, 2005), the physical and chemical properties of the decomposed straw were determined, including bulk density, total porosity, aeration porosity, water pore porosity, air-water ratio, pH, EC value, etc. A beaker with a known volume (650 mL) and weigh (W1) was used; adding the dried straw to the beaker and weighing as W2; sealing the beaker with two layers of wet gauze and soaking it in water overnight (i.e., the water should cover the top of the container), taking out the weighing as W3, and weighing the wet gauze as W4. Sealing the beaker again with wet gauze and turning it upside down, making the water in the cup drain freely until no water flows out, and weigh as W5. The indicators were calculated as the following formula:

Bulk density (BD)/(g·cm^{-3})=(W2-W1)/V;

Total porosity (TP)/%=(W3-W2-W4)/V×100;

Aeration porosity (AFP)/%=(W3-W5)/V×100;

Water pore porosity (WPP)/%=total porosity-aeration porosity;

Air-water ratio = aeration porosity/ water pore porosity.

Drying he pile material and smashing it, mixing it with the volume ratio of 1:10 of pile material and distilled water, placing it in a shaker (200 r·min^{-1}, 30 min), after shaking the supernatant was taken for later use. ORION STAR A211 pH meter was used to measure pH and FiveEasy conductivity meter was used to measure EC value.

2.3.2 Growth and Quality Index of Pepper

The ground part and fruit of pepper was sampled, and a ruler was used to measure the plant height, leaf area and plant width; a vernier caliper was used to measure the stem thickness of the pepper; when the pepper fruit matures, the yield per plant and the total yield were directly harvested and weighed.

According to the “Guide to physiological testing of plants”, the soluble protein content of pepper leaves and fruits was determined by the Coomassie brilliant blue colorimetric method; the vitamin C content of pepper fruit was determined by the molybdenum blue colorimetric method; the soluble sugar contents of pepper fruits and above-ground parts were determined by the Anthrone colorimetry; the dry matter contents of the ground part and fruit of the pepper were determined as the dry mass per plant/fresh weight per plant.

2.4 Data Analysis

The data was processed and analyzed using Excel 2007 and SPSS16.0 data analysis software.

3 RESULTS AND ANALYSIS

3.1 The Physical and Chemical Properties of the Matrix with Different Proportions

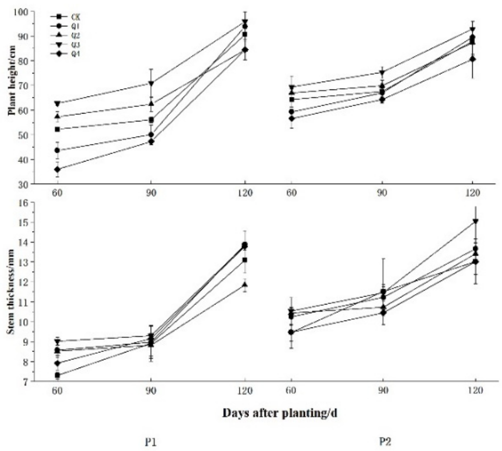
By measuring the physical and chemical properties of the cultivation substrates of the two pepper varieties on the 1st and 100th days, it was found that the pH, EC and bulk density increased to different degrees in different treatments, the aeration porosity decreased and the water pore porosity increased. The air-to-water ratio drops accordingly. It shows that through the irrigation of nutrient solution, secondary fermentation and further decomposition of humus, the matrix is loose and air-permeable, which effectively improves the physical and chemical properties of the matrix. It can be seen from the treatment of the cultivation substrates of the two pepper varieties that the pH and bulk density of the Q3 treatment were the highest at 100 days, reaching 6.8, 0.19 and 6.82, 0.18, respectively, and other indicators were better than the control group (Table 2).

Table 2: The physical and chemical properties of different Helianthus tuberosus straw composite substrates.

	treated	Bulk density($g·cm^{-3}$)		Aeration porosity (%)		Water pore porosity (%)		Air-water ratio (%)		pH		EC (ms/cm)	
		1d	100d	1d	100d	1d	100d	1d	100d	1d	100d	1d	100d
P1	CK	0.16	0.18	14.26	9.64	50.58	57.87	0.28	0.17	5.76	6.75	9.12	10.72
	Q1	0.15	0.18	14.17	12.27	49.36	53.02	0.29	0.24	5.53	6.62	9.31	11.28
	Q2	0.15	0.17	17.92	17.15	48.12	50.84	0.37	0.34	5.86	7.33	9.54	11.73
	Q3	0.16	0.19	18.91	16.54	52.31	59.34	0.36	0.28	5.97	6.80	9.28	11.90
	Q4	0.16	0.18	15.16	11.29	52.89	58.47	0.29	0.19	5.42	6.16	9.49	11.10
P2	CK	0.16	0.18	14.26	10.23	50.58	59.21	0.28	0.17	5.76	6.63	9.12	10.51
	Q1	0.15	0.18	14.17	12.37	49.36	53.81	0.29	0.23	5.53	6.71	9.31	11.32
	Q2	0.15	0.18	17.92	15.21	48.12	52.34	0.37	0.30	5.86	6.97	9.54	10.95
	Q3	0.16	0.18	18.91	16.37	52.31	58.21	0.36	0.29	5.97	6.82	9.28	11.28
	Q4	0.16	0.18	15.16	11.08	52.89	57.12	0.29	0.19	5.42	6.24	9.49	11.14

[Note] P1 is “Ledu long Pepper”, P2 is “Hangjiao No.8”, the same below.
Different lowercase letters after the numbers in the same column indicate significant differences at the 0.05 level, the same below.

3.2 The Effect of Different Substrates on the Growth and Development of Pepper



1. Plant height; 2. Stem thickness; 3. Days after planting.

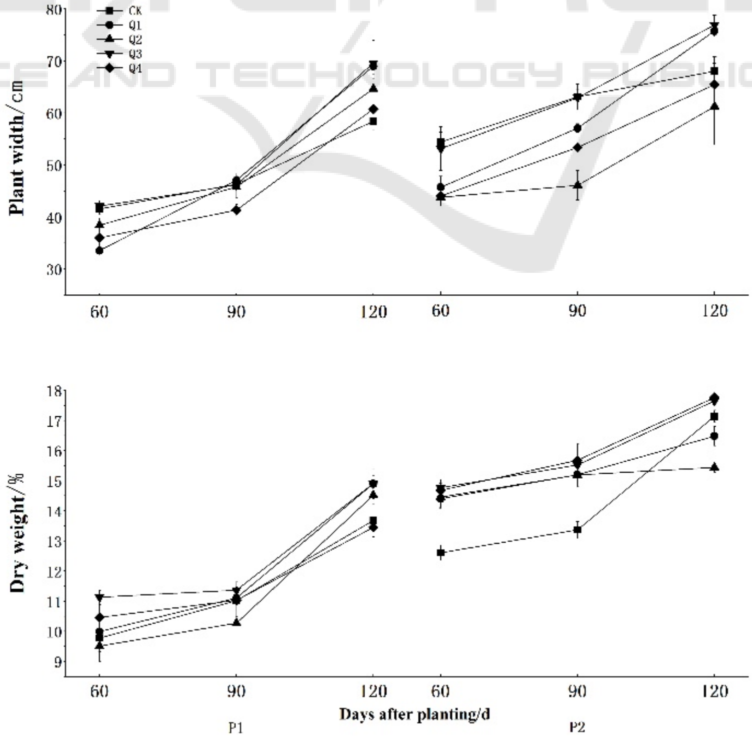
Figure 1: The effect of different substrates on pepper plant height and stem thickness.

After 60 days of planting, it was measured that the stem thickness of Q3 treatment was larger in both cultivars, 9.02 mm and 10.62 mm, which were significantly larger than other treatments. The treatment with Helianthus tuberosus straw added to the two cultivars was larger than the control group; after planting 90 days, Q3 and Q4 were larger in P1, Q1 and Q2 were smaller, and CK and Q3 were larger in P2, but the difference between the treatments was not significant; after 120 days of colonization, Q1 and Q3 were larger in P1 and significantly higher than those in Q2, the difference was significant by the analysis of variance. In P2, the Q3 treatment was larger, which was 15.23 mm, but there was no significant difference between the treatments (Figure 1). The performance of each treatment in the different periods of the two varieties shows that Q2 treatment has a certain promotion effect on pepper growth during the peak and early fruit period of pepper, but the promotion effect gradually decreases in the later stage of fruiting, and Q3 treatment can promote the growth of pepper stems during the entire growth period of pepper.

After 60 days of planting, it was measured that the plant heights of the two varieties were 52.25cm and 64.22cm in the CK treatment, respectively, which were significantly different from other treatments. In P1, there were also greater differences between the treatments with straw addition. However, there was no difference in P2; after planting 90 days, the plant height of the CK treatment in P1 was larger, 56.09cm, and it was significantly different from other treatments. In the treatment with straw addition, the plant height of the Q1 and Q3 treatments was greater than that of Q2, and the Q3 treatment had larger significant difference. In P2, the plant height of CK, Q1, Q2, and Q3 treatments was larger, and the difference between the treatments was not significant; after 120 days of planting, the plant height of Q1 treatment was larger in P1 and P2 treatments, which were 93.87cm and 89.78cm, but the difference between the treatments was not significant (Figure 1). It shows that adding straw can promote the growth of pepper plants, and the performance between two different pepper varieties is basically the same. Among them, the promotion effect of Q1 treatment is better.

After 60 days of planting, it was measured that the two cultivars treated with CK and Q3 had larger plant widths, which were 41.54 cm, 42.08 cm, 54.43 cm, and 53.13 cm, respectively, and they were ignificantly different from other treatments. After 90 days of planting, CK and Q3 were significantly different in P1. Q1, Q2, and Q3 treatments have larger plant sizes, no significant difference between treatments, and significantly larger than Q4 treatments. In P2, CK and Q3 treatments have larger plant sizes and significant differences from each treatment; after 120 days of colonization, the Q1 and Q3 in P1 and P2 treatments treatments were larger and significantly larger than the other treatments, which were 68.98 cm, 69.58 cm and 75.78 cm, 76.92 cm, respectively (Figure 2).

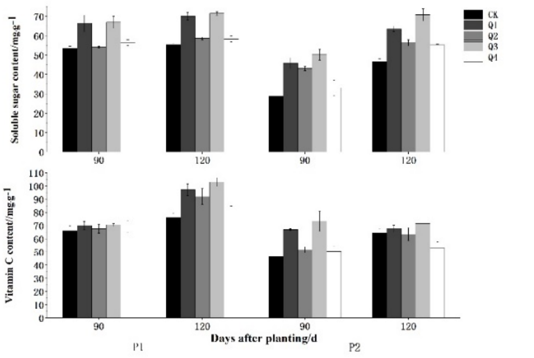
After 60 days of colonization, the dry matter content of Q3 in P1 was higher and significantly greater than that of other treatments. In P2, Q3 and Q4 treatments had no significant difference and were significantly greater than other treatments; after 90 days of colonization, Q3 treatment in P1 was significantly greater than other treatments. In P2, the dry matter content of Q2, Q3, and Q4 treatments was significantly greater than that of other treatments; after 120 days of planting, the dry matter contents of Q1 and Q3 treatments in P1 were significantly greater than that of other treatments. In P2, Q3 and Q4 treatments were significantly greater than other treatments (Figure 2). It indicated that the two varieties performed the same in terms of dry matter accumulation, and Q3 and Q4 treatments were better.



1. Plant width; 2. Dry matter weight; 3. Days after planting.

Figure 2: Effects of different substrates on pepper plant width and dry matter quality.

3.3 The Effect of Different Substrates on the Quality of Pepper Fruit

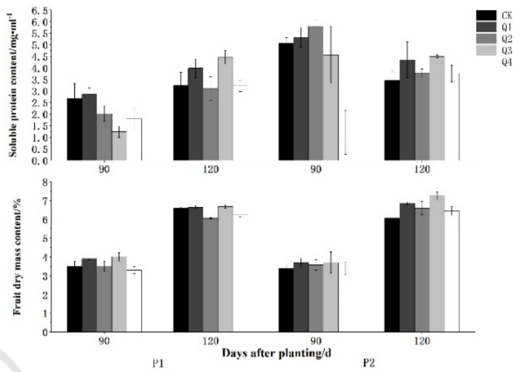


1. Soluble sugar content; 2. Vitamin C content; 3. Days after planting.

Figure 3: Effects of different matrix ratios on the soluble sugar and vitamin C content of pepper fruit.

The soluble sugar content of the fruit was measured 90 days after planting. In P1, the total soluble sugar content of Q1 and Q3 treatments was significantly higher than that of the other treatments, and the difference between the two treatments was not significant. In P2, the Q3 treatment was significantly larger than the other treatments, which was 50.32 mg/g, the treatment with Helianthus tuberosus straw added was significantly greater than that of the control; at 120 days of colonization, the soluble sugar content of the Q1 and Q3 treatments in P1 was significantly greater than the other treatments, and the content of the Q3 treatment reached 71.59 mg/g. In P2, the soluble sugar content of the Q3 treatment was significantly greater than that of other treatments, and the content of the treatment with Helianthus tuberosus straw was significantly greater than that of the control group (Figure 3). The two varieties showed similar differences in soluble sugar content, indicating that adding Helianthus tuberosus straw to the cultivation substrate can increase the soluble sugar content of pepper fruits, while Q3 treatment can better increase the soluble sugar content of fruits.

The vitamin C content of the fruit was measured 90 days after planting. In P1, the vitamin C content of the Q3 treatment was greater than that of the other treatments, but the difference between the treatments was not significant. In P2, the Q1 and Q3 treatments were significantly greater than the other treatments, 66.98 mg/ g and 73.40mg/g; at 120 days of colonization, the vitamin C content of Q1 and Q3 treatments in P1 was significantly greater than that of the other treatments, both exceeded 95mg/g, and the content of Q3 treatment reached 102.95mg/g. In P2, vitamin C contents of CK, Q1, Q2, and Q3 treatments were significantly larger than Q4 treatment. The Q3 treatment had the largest value of 71.50 mg/g. The treatment content with straw addition was significantly greater than the control group with sheep manure (Figure 3). The two cultivars showed similar differences in vitamin C content. The vitamin C content of the treatment with Helianthus tuberosus straw was better than the control group, and the Q3 treatment performed best among them.



1. Soluble protein content; 2. Fruit dry matter content; 3. Days after planting.

Figure 4: Effects of different matrix ratios on the soluble protein and dry matter content of pepper fruit.

The soluble protein content of the fruit was measured 90 days after planting. In P1, the soluble protein content of Q1 treatment was greater than other treatments, but the numerical difference was not big and the content was small. In P2, Q2 treatment was greater than other treatments but there was no significant difference between treatments; when the planting for 120 days, the soluble protein content of both cultivars under Q3 treatment was higher, but the values between treatments were smaller and there was no significant difference (Figure 4), indicating that adding Helianthus tuberosus straw has no obvious effect on fruit resistance.

The dry matter content of the fruit was measured after 90 days of planting. In P1, the dry matter content of Q1 and Q3 treatments was significantly higher than that of other treatments, and the content of Helianthus tuberosus straw added treatment was greater than that of the control group. In P2, the dry matter content of Q3 treatment was greater than other treatments. However, there was no significant difference among the treatments; in P1, the dry matter content of the CK, Q1, and Q3 treatments was greater than that of the other treatments and there was no significant difference between the three treatments. In P2, the dry matter content of the Q3 treatment was significantly greater than other treatments, and the content of treatment with Helianthus tuberosus straw added was greater than that of the control group (Figure 4).

3.4 The Effect of Different Substrates on the Yield of Pepper

The addition of Helianthus tuberosus stalks had an effect on the number of fruits per plant, the yield per plant and the total yield of the two pepper varieties, but the effect was greater in P2 than in P1. In P1, there was no significant difference in the number of fruits per plant, yield per plant and total yield of each treatment. The number of fruits per plant of CK treatment was slightly higher than that of other treatments. The yield of each plant and total yield of Q3 treatment were higher than those of other varieties; in P2, the number of fruits per plant in Q3 treatment was the highest and was significantly larger than that in other treatments, which was 32.80. The yield of each plant and total yield were also the largest in Q3 treatment, reaching 1.37 kg and 4738.87 kg (Table 3). It shows that adding Helianthus tuberosus stalks to the cultivation substrate can effectively increase the yield of pepper, and the Q3 treatment of Helianthus tuberosus stalks has the best yield increase effect.

Table 3: The yield of peppers with different ratios of substrates.

Treated	P1				P2			
	Number of fruits on per plant	Yield per plant (kg)	Early production (kg)	Total output (kg)	Number of fruits on per plant	Yield per plant (kg)	Early production (kg)	Total output (kg)
CK	23.87± 0.89a	1.09± 0.04a	1175.8± 93.32a	3792.94± 155.54a	29.40± 1.33a	1.28± 0.01ab	1510.06± 70.60ab	4441.35± 50.82ab
Q1	22.13± 1.38a	1.13± 0.09a	1288± 213.76a	3904.98± 328.01a	31.87± 2.49a	1.34± 0.06a	1481.33± 129.59a	4629.15± 196.35a
Q2	20.47± 1.11a	1.03± 0.10a	1070± 189.43a	3568.88± 339.56a	28.63± 5.49a	1.26± 0.13ab	1523.59± 269.80ab	4353.11± 449.67ab
Q3	23.13± 0.58a	1.16± 0.03a	1321.80± 78.60a	4005.46± 106.26a	32.80± 2.53a	1.37± 0.03a	1611.22± 56.33a	4738.87± 90.86a
Q4	20.60± 4.27a	0.96± 0.13a	1031.16± 261.29a	3326.33± 450.44a	24.32± 3.39a	1.02± 0.17b	1170.56± 340.35b	3547.16± 576.87b

4 DISCUSSION

The soilless culture substrate needs to have suitable physical and chemical properties. Generally speaking, the bulk density of the substrate is in the range of $0.1 \sim 0.8 g \cdot cm^{-3}$ (Zhang, 2015), the aeration porosity is more than 15%, and the water pore porosity are more than 60%. Studies have shown that the addition of Helianthus tuberosus straw can make the aeration porosity of the composite matrix more approach the aeration porosity requirements of the ideal matrix (Li, 2003). According to the test data in this paper, pH and EC have different degrees of increase in different treatments; the bulk density and water pore porosity are low, which does not meet the requirements of ideal matrix bulk density and water pore porosity. The reason may be caused by the degree of straw crushing. As the bulk density is directly related to the texture of the straw and the size of the particles, it affects the compactness of the straw, as well as the water-holding and air-permeable capacity (Liu, 2007). The Q2 and Q3 treatments have larger aeration porosity, which meets the requirement that the ideal matrix aeration porosity should be greater than 15%, and is in line with the results of previous studies (Li, 2003). Aeration porosity, pH and other indicators of Q3 treatment are significantly better than other groups, and the stem thickness, soluble sugar content, vitamin C content and yield of pepper are also increased in Q3 treatment. The reason may be that relatively suitable water pore porosity and aeration porosity make the substrate support and water retention capacity strong, which is conducive to the growth and development of plant roots (Fu, 2010).

Previous studies have shown that the use of organic substrates can increase crop growth (Jiang, 1996). The treatments adding Helianthus tuberosus stalks have a relatively obvious promotion effect on the synthesis of pepper biomass during the entire growth period of pepper, which is specifically reflected in the promotion of growth indicators such as plant height, stem thickness and plant width in different degrees. However, the different ratio of Helianthus tuberosus stalks and sheep manure has different promotion effect on the growth indicators of pepper. The treatment with Helianthus tuberosus stalks has not obvious promotion effect in the early stage of pepper growth and the difference between treatments is not significant, but it significantly increases the plant width and other indicators in the later stage of pepper growth, indicating that the treatment of adding Helianthus tuberosus straw and sheep manure has insufficient short-term fertilizer capacity but has a long and stable fertilizer effect, which promotes the growth and development of pepper in the later period [14], and the promotion effect on stem thickness and plant width is the most obvious when the ratio of Helianthus tuberosus straw to sheep manure is 1:3.

Research has shown that the nutrient transformation and release of the substrate itself plays a very important role in the fertilizer supply of tomato plants. The substrate has biological activity (Sun, 2019), and its feeding mechanism is different from the nutrient solution. Organic wastes such as straws can be used as substrates after being decomposed by composting and fermentation. They contain large amounts of elements and trace elements required for plant growth. In addition, during the cultivation process, the substrates themselves will continue to ferment and release nutrients continuously to promote the growth and development of plants (Wang, 2004). In this experiment, the addition of Helianthus tuberosus stalks can indeed promote the synthesis of soluble sugar and vitamin C in peppers, promote the accumulation of fruit dry matter, enhance disease resistance and increase yield, but the promotion effect is very large with the addition of Helianthus tuberosus stalks and sheep manure. relation. Studies have shown that the co-decomposition of crop stalks and sheep manure can reduce the C/N in the compost to a certain extent, and can also alleviate the competition between microorganisms and crops for nitrogen sources after being applied to the soil (Wang, 2011). Therefore, the reason may be that the change of sheep manure content leads to the change of substrate carbon-nitrogen ratio and nutrients, which affects the growth of pepper. It can be seen from the various data that the Helianthus tuberosus straw and sheep manure are treated at a ratio of 1:3, that is, the Q3 treatment is better than the other two treatments with added straw in all indicators, but the more Helianthus tuberosus straw is added, All indicators are declining.

The strong ecological adaptability of Helianthus tuberosus and its huge application potential as an energy plant, as well as the important position of the research and development of cultivation substrates in agriculture, make the substrateization of Helianthus tuberosus stalks have broad application space and prospects.

5 CONCLUSION

The Helianthus tuberosus straw and sheep manure are used in the pepper cultivation substrate in different proportions, which can improve the physical and chemical properties of the cultivation substrate. When the cultivation substrate ratio is $V_{\text{Helianthus tuberosus straw}}$: $V_{\text{sheep manure}}$: $V_{\text{substrate soil}}$: V_{perlite}: $V_{\text{vermiculite}}$=1: 3: 3: 1: 1, the pepper biomass will increase, which will promote the growth of pepper plants, increase the fruit quality and the yield of pepper.

FUND PROJECT

This article is the National Natural Science Foundation of Qinghai Province (2021-ZJ-921), Qinghai Province Science and Technology Achievement Transformation Special Project (2020-NK-121), Qinghai Province Agriculture and Forestry Science Innovation Fund (2019-NKY-02), Qinghai Province Science and Technology Department Key Laboratory Project (2020-ZJ- Y02) One of the phased results.

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