The Input of Chemical Fertilizer and Soil Nutrient in Apple Orchard

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Abstract In order to get the formation about the content of alkali-hydrolyzable nitrogen in soil, available phosphorus and available potassium, and the input of chemical fertilizer in apple orchard, we survey 25 peasant households' input of chemical fertilizer in apple orchard, and collect soil samples for measuring and analysis. The results show that the average input of nitrogen, phosphorus and potassium nutrient is 839.6 kg/hm^2, 520.4 kg/hm^2, and 899 .7 kg/hm^2, respectively; the input proportion of nitrogen to phosphorus to potassium nutrient is 1:0.62:1.07; in 0 -60 cm soil, the average content of alkali-hydrolyzable nitrogen is 53.49 mg/kg, the average content of available phosphorus in soil is 70.73 kg/mg, and the average content of available potassium in soil is 180.1 mg/kg (the proportion of alkali-hydrolyzable nitrogen to available phosphorus to available potassium in soil is 1: 1.32: 3.37). It indicates that the overall level of input of chemical fertilizer in apple orchard is relatively high; the content of alkali-hydrolyzable nitrogen in soil is very low on the whole, the content of available phosphorus in soil is very high, and the content of available potassium in soil is high.

Key words Apple, Chemical fertilizer, Soil nutrient

Apple production in Yantai City has the typical characteristics of high input and high yield, having put considerable chemical fertilizer into soil annually. The blind use of chemical fertilizer is widespread, and excessive application of chemical fertilizer can cause a decline in the quality of the apple and cause environmental pollution[1-2]. We conduct research on the input of chemical fertilizer into soil and soil nutrient in orchard, which aims to explore the reasonable degree of the current input of chemical fertilizer into soil and soil nutrient content in orchard of Yantai City, to provide a scientific basis for guiding management of soil nutrient in orchard.

1 Materials and method

1.1 Survey of peasant households and calculation of the input of chemical fertilizer As for the household survey, we use a combination of questionnaires and field survey. In April 2010, we surveyed the application of fertilizer in soil and yield in orchard in recent three years. Sampling sites are the apple orchards practising intensive production in Longquan Town, Jianggezhuang Town and Yulindian Town, Mouping District, Yantai City. 25 sampling sites are selected; 25 peasant households are surveyed; 25 soil samples are taken.

The input of chemical fertilizer is calculated based on the pure nutrients (N, P_2O_5, K_2O), and the calculation method is as follows:

$$I_j = \sum_{i,j=1}^{n} C_i \cdot C_j$$

where I_j is the total input of nutrient j (j signifies N, P_2O_5, K_2O); C_i is the total input of fertilizer i; C_j is the content of nitrogen nutrient in fertilizer j.

1.2 Collection and processing of soil samples In each orchard, 5 sampling points with a area of 500 -600 m^2, are selected in the shape of zigzag. Then the soil samples in the soil layer of 0 -20 cm, 20 -40 cm, and 40 -60 cm are selected, respectively. All layers of soil sample are mixed into one sample, about 1 kg. After being air-dried, ground, and sieved, the soil samples are for test.

1.3 Measuring method Alkali-hydrolyzable nitrogen uses Petri-dish method; available phosphorus uses Olsen method; available potassium uses NH_4 OAc extraction-flame photometric method.

2 Results and analysis

2.1 The input of chemical fertilizer to soil in orchard It can be seen from Table 1 that the minimum input of nitrogen fertilizer in apple orchard is 288.0 kg/hm^2, the maximum input of nitrogen fertilizer in apple orchard is 1 162.5 kg/hm^2, and the average input of nitrogen fertilizer in apple orchard is 839.6 kg/hm^2; the minimum input of phosphorus fertilizer is 144.0 kg/hm^2, the maximum input of phosphorus fertilizer is 1 125.0 kg/hm^2, and the average input of phosphorus fertilizer is 520.35 kg/hm^2; the minimum input of potassium fertilizer is 405.0 kg/hm^2, the maximum input of potassium fertilizer is 1260. 0kg/hm^2, and the average input of potassium fertilizer is 899.7 kg/hm^2. The input ratio of nitrogen, phosphorus and potassium nutrient is 1:0.6:1.07.

2.2 Available nutrient in soil

2.2.1 Alkali-hydrolyzable nitrogen in soil. The content of alkali-hydrolyzable nitrogen in soil of 25 apple orchards surveyed can be seen in Table 2. The minimum content of alkali-hydrolyzable nitrogen in 0 -20 cm soil in apple orchard is 43.78 mg/kg, the maximum content of alkali-hydrolyzable nitrogen in 0 -20 cm

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soil in apple orchard is 76.06 kg/mg, and the average content of alkali-hydrolyzable nitrogen in 0 –20 cm soil in apple orchard is 54.37 mg/kg; the minimum content of alkali-hydrolyzable nitrogen in 20 –40 cm soil in apple orchard is 42.29 mg/kg, the maximum content of alkali-hydrolyzable nitrogen in 20 – 40 cm soil in apple orchard is 68.81 kg/mg, and the average content of alkali-hydrolyzable nitrogen in 20 – 40 cm soil in apple orchard is 53.00 mg/kg; the minimum content of alkali-hydrolyzable nitrogen in 40 – 60 cm soil in apple orchard is 41.79 mg/kg, the maximum content of alkali-hydrolyzable nitrogen in 40 –60 cm soil in apple orchard is 65.27 kg/mg, and the average content of alkali-hydrolyzable nitrogen in 40 –60 cm soil in apple orchard is 53 mg/kg. There is little difference in the content of alkali-hydrolyzable nitrogen in soil at all levels. The average content of alkali-hydrolyzable nitrogen in 0 – 60 cm soil is 53.49mg/kg.

Table 1 The input of chemical fertilizer to soil in orchard

Number mark	The input of chemical fertilizer		
	The input of nitrogen fertilizer kg/hm^2	The input of phosphorus fertilizer kg/hm^2	The input of potassium fertilizer kg/hm^2
1	864.0	573.0	960.0
2	786.0	393.0	883.5
3	1 080.0	540.0	1 170.0
4	1 162.5	582.0	1 260.0
5	810.0	630.0	840.0
6	810.0	630.0	840.0
7	810.0	630.0	840.0
8	1 080.0	709.5	1 080.0
9	1 080.0	709.5	1 080.0
10	1137.0	568.5	1 341.0
11	774.0	603.0	804.0
12	870.0	474.0	1029.0
13	775.5	388.5	802.5
14	702.0	351.0	760.5
15	288.0	144.0	312.0
16	1 012.5	540.0	1 147.5
17	972.0	486.0	1053.0
18	972.0	486.0	1053.0
19	807.0	403.5	873.0
20	1 125.0	1 125.0	1 125.0
21	1 012.5	1 012.5	1 012.5
22	442.5	222.0	480.0
23	378.0	189.0	405.0
24	396.0	198.0	429.0
25	843.0	421.5	912.0
Average	839.6	520.4	899.7
Amplitude of variation	288.0 –1 162.5	144.0 –1 125.0	405.0 –1 260.0

2.2.2 Available phosphorus in soil. The content of available phosphorus in soil of 25 apple orchards surveyed can be seen in Table 3. The minimum content of available phosphorus in 0 –20 cm soil in apple orchard is 27.16 mg/kg, the maximum content of available phosphorus in 0 – 20 cm soil in apple orchard is 133.22 kg/mg, and the average content of available phosphorus in 0 –20 cm soil in apple orchard is 87.68 mg/kg; the minimum content of available phosphorus in 20 –40 cm soil in apple orchard is 31.06 mg/kg, the maximum content of available phosphorus in 20 – 40 cm soil in apple orchard is 142.86 kg/mg, and the average content of available phosphorus in 20 –40 cm soil in apple orchard is 71.00 mg/kg; the minimum content of available phosphorus in 40 –60 cm soil in apple orchard is 14.59 mg/kg, the maximum content of available phosphorus in 40 – 60 cm soil in apple orchard is 164.68 kg/mg, and the average content of available phosphorus in 40 –60 cm soil in apple orchard is 53.52 mg/kg. There is obvious difference in the content of available phosphorus in soil at all levels (87.68 kg/mg in 0 –20cm; 71.00 mg/kg in 20 –40cm; 53.53 mg/kg in 40 –60cm). The average content of available phosphorus in 0 –60 cm soil is 70.73 mg/kg.

Table 2 The content of alkali-hydrolyzable nitrogen in soil in apple orchard

Number mark	Alkali-hydrolyzable nitrogen//mg/kg			
	0 –20 cm	20 –40 cm	40 –60 cm	Average
1	61.99	58.71	55.95	58.88
2	59.15	59.80	60.26	59.74
3	55.99	52.61	57.91	55.50
4	57.46	54.14	56.70	56.10
5	49.06	46.16	52.50	49.24
6	43.78	46.83	42.26	44.29
7	43.48	44.08	44.28	43.95
8	43.91	44.74	43.96	44.20
9	45.66	42.29	44.22	44.06
10	45.98	47.73	48.79	47.00
11	49.46	51.82	53.13	51.47
12	56.04	59.00	60.18	58.40
13	65.25	68.81	61.96	65.40
14	58.69	57.84	60.17	58.9
15	58.32	54.29	65.27	59.29
16	58.5	59.31	53.17	56.99
17	55.11	48.16	54.65	52.64
18	49.31	55.05	51.5	51.95
19	58.37	48.10	52.08	52.85
20	76.06	58.91	54.13	63.00
21	55.44	52.59	48.24	52.09
22	59.13	63.25	61.77	61.38
23	58.38	55.53	58.14	57.25
24	47.43	44.28	41.79	44.50
25	47.46	51.64	44.22	47.77
Average	54.37	53.00	53.00	53.49
Amplitude of variation	43.78 –76.06	42.29 –68.81	41.79 –65.27	

2.2.3 Available potassium in soil. The content of available potassium in soil of 25 apple orchards surveyed can be seen in Table 4. The minimum content of available potassium in 0 –20 cm soil in apple orchard is 65.37 mg/kg, the maximum content of available potassium in 0 – 20 cm soil in apple orchard is 386.33 kg/mg, and the average content of available potassium in 0 –20 cm soil in apple orchard is 225.94 mg/kg; the minimum content of available potassium in 20 –40 cm soil in apple orchard is 53.17 mg/kg, the maximum content of available potassium in 20 – 40 cm soil in apple orchard is 337.19 kg/mg, and the average content of available potassium in 20 – 40 cm soil in apple orchard is 176.53 mg/kg; the minimum content of available potassium in 40 –60 cm soil in apple orchard is 39.65 mg/kg, the maximum content of available potassium in 40 –60

cm soil in apple orchard is 287.12 kg/mg, and the average content of available potassium in 40 – 60 cm soil in apple orchard is 137.82 mg/kg. There is obvious difference in the content of available potassium in soil at all levels (225.94 kg/mg in 0 – 20 cm; 176.23 mg/kg in 20 – 40 cm; 137.82 mg/kg in 40 – 60 cm). The average content of available potassium in 0 – 60 cm soil is 180.1 mg/kg.

Table 3 Content of available phosphorus in soil in apple orchard

Number mark	Available phosphorus // mg/kg			
	0 – 20 cm	20 – 40 cm	40 – 60 cm	Average
1	88.50	37.63	16.19	47.44
2	95.92	56.43	33.39	61.91
3	136.19	72.61	110.05	106.68
4	113.87	168.33	164.68	148.96
5	36.97	66.84	40.09	47.96
6	84.48	40.57	40.36	55.14
7	75.03	58.33	18.00	50.45
8	27.16	57.90	22.77	35.94
9	52.34	38.12	17.06	35.85
10	46.75	52.31	61.09	53.38
11	102.44	111.43	64.99	92.95
12	133.22	104.19	108.97	115.46
13	68.66	73.38	52.94	64.99
14	116.88	72.88	28.97	72.91
15	110.07	39.09	31.56	60.24
16	74.16	55.27	13.79	47.74
17	78.30	73.62	62.62	71.51
18	149.24	142.86	79.51	123.87
19	105.17	109.22	86.15	100.18
20	96.68	31.06	14.59	47.44
21	89.55	38.76	14.11	47.47
22	132.81	120.05	84.89	112.48
23	21.78	22.43	15.91	20.04
24	42.18	37.47	30.89	36.85
25	113.63	141.35	78.08	111.02
Average	87.68	71.00	53.52	70.73
Amplitude of variation	27.16 – 133.22	31.06 – 142.86	14.59 – 164.68	

2.3 Soil nutrient classification According to Wang Haiyun's classification standard of available nutrient in soil of apple orchard in Shandong Province[3], we classify the status of content of nutrient in 25 soil samples, and this standard divides the nutrient in soil into five levels ("high", "suitable", "moderate", "low", "very low"). The content of alkali-hydrolyzable nitrogen in 0 – 60 cm soil greater than 50 mg/kg falls within the level "low", and there are 17 samples, accounting for 68%; the content of alkali-hydrolyzable nitrogen in 0 – 60 cm soil smaller than 50 mg/kg falls within level "very low", and there are 8 samples, accounting for 32%. It indicates that within the scope of the survey, the content of alkali-hydrolyzable nitrogen in soil of apple orchard is very low overall. The content of available phosphorus greater than 50 mg/kg falls within the level "high", indicating that within the scope of the survey, the content of available phosphorus in soil of apple orchard is very high. The content of available potassium in soil greater than 200 mg/kg falls within the level "high", and there are 8 samples, accounting for 32%; the content of available potassium in soil in 200 – 150 mg/kg falls within the level "suitable", and there are 10 samples, accounting for 40%; the content of available potassium in soil in 150 – 100 mg/kg falls within the level "moderate", and there are 2 samples, accounting for 8%; the content of available potassium in soil in 100 – 50 mg/kg falls within the level "low", and there are 5 samples, accounting for 20%; the content of available potassium in soil less than 50 mg/kg falls within the level "very low". It indicates that the content of available potassium in soil of apple orchard is high.

Table 4 Content of available potassium in soil in apple orchard

Number mark	Available potassium // mg/kg			
	0 – 20 cm	20 – 40 cm	40 – 60 cm	Average
1	234.29	165.36	155.94	185.19
2	123.42	107.30	39.65	90.12
3	213.84	172.28	138.57	174.89
4	373.84	337.19	287.12	332.72
5	88.37	69.41	78.88	78.89
6	96.18	85.73	101.96	94.62
7	200.64	175.03	158.79	178.15
8	146.59	151.97	59.94	119.5
9	65.37	53.17	51.81	56.78
10	93.79	61.31	69.41	74.84
11	386.33	164.21	196.69	249.08
12	295.53	196.71	82.97	191.74
13	158.76	161.49	133.02	151.09
14	218.36	157.39	122.22	165.99
15	276.59	164.14	120.88	187.2
16	131.71	99.18	93.79	108.23
17	309.19	230.62	180.53	240.11
18	328.16	306.34	200.78	278.43
19	288.79	272.54	222.49	261.27
20	326.39	279.39	168.24	258.01
21	235.93	189.94	80.29	168.72
22	245.48	191.29	153.35	196.71
23	207.60	173.59	137.08	172.76
24	269.89	214.32	172.34	218.85
25	333.48	233.38	238.68	268.51
Average	225.94	176.53	137.82	180.1
Amplitude of variation	65.37 – 386.33	53.17 – 337.19	39.65 – 287.12	

3 Conclusions

The average input of nitrogen, phosphorus and potassium nutrient is 839.6 kg/hm^2, 520.4 kg/hm^2, and 899 .7 kg/hm^2, respectively; the input proportion of nitrogen to phosphorus to potassium nutrient is 1:0.62:1.07. In 0 – 60 cm soil, the average content of alkali-hydrolyzable nitrogen is 53.49 mg/kg, the average content of available phosphorus in soil is 70.73 kg/mg, and the average content of available potassium in soil is 180.1 mg/kg (the proportion of alkali-hydrolyzable nitrogen to available phosphorus to available potassium in soil is 1:1.32:3.37). According to Wang Haiyun's classification standard of available nutrient in soil of apple orchard in Shandong Province, we know that the overall level of input of chemical fertilizer in apple orchard is relatively high; the content of alkali-hydrolyzable nitrogen in soil is very low on the whole, the content of available phosphorus in soil is very high, and the content of available potassium in soil is high.

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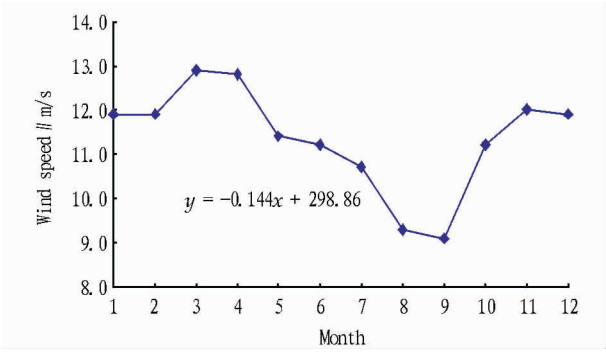

Fig.3 Change curve of the maximum wind speed in each month in Zhucheng City

quency of occurrence, which is one of the most common meteorological disasters in Zhucheng City, often exerting adverse impact on agricultural production in Zhucheng City. From statistics on disaster weather in Zhucheng City in recent two decades, the gale disaster mainly appears in winter and spring, and there is relatively rare gale disaster in summer and autumn.

5.1 The hazards arising from windy weather in spring and winter and defensive measures With adjustment of crop farming structure in Zhucheng City in recent years, the greenhouse planting area in winter and spring in Zhucheng City is increasing. According to statistics of agricultural departments in Zhucheng City, the greenhouse planting area reached 20 000 hectares at the end of 2010. The income from the cultivation of vegetables and fruits in the greenhouse has become the main source of income for local farmers. The gale in this period often causes great harm, damaging or blowing away the film, even destroying the greenhouse. It will cause great losses of the crops in greenhouse due to cold and pressure; total crop failure when serious.

Defensive measures are as follows. When it is forecasted that there will be windy weather, we should fix the air hole of film, and press film line or belt during the day; fix straws and other coverings, frequently check and repair the damaged films, and reinforce the house body at the same time during the night.

5.2 The hazards arising from windy weather in summer and defensive measures Winter wheat and summer maize are the major field crops in Zhucheng City. Early summer is the harvest season of winter wheat; July and August are the vigorous growth period of summer maize. The windy weather in this period is mainly the thunderstorms caused by severe convective weather, and the instantaneous wind is strong, so it will cause great danger, often making a large area of wheat, corn and other crops flattened, resulting in significant decline in yield.

The defensive measures are as follows. First, the improved varieties resisting flattening should be selected when planting. In the growth process of crops, the chlormequat chloride should be sprayed scientifically and timely, in order to enhance the capacity of straws to resist flattening. Second, the meteorological departments should formulate countermeasures to cope with the strong convective weather, and actively carry out artificial weather modification operations, to curb the development of severe convective weather to the extreme, and reduce the intensity and frequency of the strong wind.

6 Conclusions

(i) Over thirty-nine years, the annual maximum wind speed in Zhucheng City tends to decline at the rate of 1.45 m/s every 10 years; the average maximum wind speed in each season also tends to decline one the whole (It falls fastest in winter, with decline rate of 1.73 m/s every 10 years; it is close to the average annual maximum wind speed in spring and autumn, with decline rate of 1.44 m/s and 14.8 m/s every 10 years, respectively; it falls slowest in summer), and the extreme value of the maximum wind speed occurs mainly in spring and winter, so we should strengthen forecasting and monitoring of the maximum wind speed in winter and spring.

(ii) The curve of changes in the monthly maximum wind speed in Zhucheng City assumes diminishing shape of " two peaks and one trough". The peak value appears in March and November, and the minimum value appears in September.

(iii) The strong wind disaster mainly occurs in spring, summer and winter, so during these seasons, we should strengthen forecast of the strong wind and adopt defensive measures to reduce losses.

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