

UTILIZATION OF *ARACHIS PINTOI* IN RED SOIL REGION AND ITS EFFICIENCY ON WATER-SOIL CONSERVATION IN CHINA

Huang Yi-bin, Tang Long-fei, Zheng Zhong-deng, Chen En, Ying Zhao-yang

Eco-Agriculture Research Center, Fujian Academy of Agr. Sci., Fuzhou, 350013, China.

Abstract

Arachis pinto cv. Amarillo is leguminous forage which was first introduced from Australia into China through an ACIAR Project in 1989. *A. pinto* is a perennial, crawling herbaceous plant with the characteristics of a shallow root system, long flowering duration, and extensive branching and rooting. With its ability to tolerate acid and barren conditions, and drought tolerance, it has been widely cultivated in the red-soil regions in China, especially as an intercrop in orchard areas. In a continuous four-year in situ assessment, 38 instances of runoff totalling 61t ha⁻¹ were observed in the orchard area intercropped with *A. pinto*, whereas 178 runoff events, totalling 2482.4 t ha⁻¹ and soil loss of 42.26 t ha⁻¹ in CK orchard. Intercropping *A. pinto* also improved soil physi-chemical character. After 3-years intercropping, orchard soil B.D in 0-20 cm was 0.98 g cm⁻³, soil porosity was 25.73%, water content was 22.5%; whereas in CK was 1.06 g cm⁻³, 18.6% and 21.5% respectively. Soil pH increased from 5.12 to 6.25, soil O.M. from 1.526% to 1.930%, total N from 0.079% to 0.14%, total P from 0.025% to 0.030. *A. pinto* contains 15.88% crude protein, 1.36% fat, 29.43% cellulose, rich in nutrition and good palatability. Feeding *A. pinto* to rabbits produced an average weight increase of 21.67 g d⁻¹, which was higher than where the animals were feed weeds (10.73 g d⁻¹). In the south subtropical area of China, the plants of *A. pinto* maintain year-round ever-green and bloom. Owing to its visual appeal, it is gradually becoming an ornamental turfgrass. However, *A. pinto* yields little seed in China, and its multiplication is mainly through asexual propagation. When spacing distance was 10 × 10 cm², the grass coverage reached 49% on the hill area (barren soil, 0.5% O.M) after planting for 30d, 87% for 45d, 91% for 60d; whereas on garden area (fertile soil, 1.5% O.M), coverage reached 80% for 30d. Further international cooperation is needed to promote the popularization of *A. pinto* cultivation in China.

Additional Keywords: Amarillo, soil and water conservation

Introduction

Arachis pinto cv. Amarillo is a leguminous plant originally from Brazil. It was introduced to China from Australia via an ACIAR Project in 1989. *A. pinto* is a perennial, crawling herb plant with the characteristics of a shallow root system, long flowering duration, large amount of branch and rooting in every node. It is suitable for growth in tropical or sub-tropical regions. Its height of straw layer ranges 15-30 cm. Owing to its merits of acid-tolerance, barren land-tolerance and drought-tolerance; it has been widely cultivated in red-soil regions in China for water-soil conservation, soil fertility enhancement and as an ornamental turfgrass. It is especially useful as an intercrop in orchard areas. From 1990, we started studies of the biological character of *A. pinto*, its use for soil conservation in orchards, for raising the herbivores, also for increasing the fertility of red soil. Some of our results are reported here.

Materials and Methods

Study on the effect of A. pinto on soil and water conservation and fruit growth

Field sites

The experiment was done at the runoff plots of red soil orchard of Fujian Academy of Agricultural Science, located in Yuchi watershed, Youxi county, Fujian province. Geography latitude 26°25'N, longitude 117°57'E, gradient 15° and southeast oriented. Every plot is 25 m in length, 4 m in width and separated by cement boards. A 1 m³ pool was set under every plot to collect sediment.

Treatments

Four treatments were studied on the effect of different reclamation of red soil orchards on soil situation. They are: T1, terrace with grass: built the contour terrace for citrus trees and planted *A. pinto* on terrace surface outside the crown of every citrus. *Digitaria smutsii* cv. Premier was planted on terrace ridges while *Paspalum notatum* cv. Flugge (Bahia grass) was planted on terrace slope; T2, traditional Chinese orchard: besides without grass, the other is same to T1; T3, slope with grass: planted the citrus trees along the natural slope and *A. pinto* on soil surface outside the crown of every citrus. *Digitaria smutsii* cv. Premier and *Paspalum notatum* cv. Flugge were planted between 2 lines of citrus trees in 50 cm width; T4, slope without grass: besides without grass, the other is same to T3. Every plot is 100 m² area and planted with 8 citrus trees. Every treatment was replicated 3 times and randomly arranged.

Study on the effect of fresh A. pinto on feeding meat rabbits

Daily diet

Fodder components were: corn flour 12%, bran 59%, inferior flour 18%, bean cake 4.5% fishmeal 4% gypsum 2% salt 0.5%. Nutrient component is: CP 16.51%, CF 5.48%, DE 2.78 Mcal/Kg, Ca 0.99%, P 8.81%. 50g of daily diet for every rabbit was supplement.

Treatments

Based on daily diet, 2 treatments was set depended on added different fresh forages. They are: . 250g of A. pinto + 250g of D. smutsii; (CK). 500g local forage. 3 replications for every treatment, and 7 rabbits every rep.

Method

One cage for each rabbit. Everyday, feed on 250g of fresh forage and 50g of daily diet at 7:30am and served another 250 g of fresh forage at 7:30 pm. Collected and weighted the remains every night. The experiment last 30d after a 7 days primary experiment. The beginning weighted is 1.24-1.28 kg per rabbit. The rabbit species Fujian local yellow meat rabbit.

Results and Discussion

Study on the effect of A. pinto on soil-water conservation and fruit growth

By tradition, Chinese farmers weed the orchards for prevent the pests and convenient for cultivation. But it destroyed the ecological diversity and bared the soil, which aggravated the soil erosion. The precipitation in southeast of China is rich and strong especially in typhoon season. For example, in Fujian province, the soil erosion mainly occurred in July to October when it is typhoon season normally. The 80% of Fujian province’s soil is red soil, the rainfall combine with soil characteristic and traditional cultivating manner make the 70% of orchard occurred soil erosion. Consequently, a new technology that built the contour terrace for fruit trees and planted the forages/grasses on terrace surface for prevent from erosion is popularizing in southeast of China. Our research indicated that Intercropping *A. pinto* in the orchard areas possesses high function for water-soil conversation. According to a continuous four-year *in situ* determination from 1997 to 2000, 38 run-off with 61t ha⁻¹ total run-off amount were observed in the orchard area where intercropped *Arachis pinto*, whereas 178 run-off with 2482.4 t ha⁻¹ total run-off amount were observed in CK orchard, in which the losing amount of sedimentation was 42.26 t ha⁻¹. (Table 1).

Table 1. The effect of different reclaiming and cultivating manners on run-off in soil surface

| Treatment | Run-off times | | | | | Run-off amount (t h ⁻¹ m ⁻²) | | | | |
|-----------------------------|---------------|------|------|------|-------|---|--------|--------|--------|---------|
| | 1997 | 1998 | 1999 | 2000 | total | 1997 | 1998 | 1999 | 2000 | total |
| terrace with grass | 0 | 1 | 37 | 0 | 38 | 0 | 3.0 | 58.0 | 0 | 61.0 |
| traditional Chinese orchard | 28 | 43 | 59 | 48 | 178 | 492.0 | 597.5 | 765.5 | 627.4 | 2419.4 |
| slope with grass | 35 | 20 | 39 | 22 | 116 | 290.7 | 51.0 | 39.5 | 28.0 | 409.2 |
| slope without grass | 47 | 47 | 60 | 48 | 202 | 4007.1 | 4125.8 | 2930.5 | 2777.0 | 13840.4 |

Intercropping *Arachis pinto* also improves soil physical chemistry character. After intercropping *A. pinto* in orchard for three years, soil B.D in 0-10 cm was 0.96 g cm⁻³, soil porosity was 26.6%, Soil moisture was 23.2%; whereas in CK area, the soil B.D, porosity and water content was 1.05 g cm⁻³, 20.1% and 21.1% respectively (Table 2). After three-years intercropping with *A. pinto* in orchard, soil pH increased from 5.12 to 6.25, soil O.M. from 1.53% to 1.93%, total N from 0.079% to 0.104%, total P from 0.025% to 0.030%, but total K decreased from 2.323% to 1.964% while available K increased from 100.06 to 253.24 mg kg⁻¹ (Table 3).

Table 2. The effect of different cultivating manners on soil bulk density porosity and moisture

| Treatment | Soil bulk density g cm ⁻³ | | Soil porosity (%) | | Soil moisture (%) | | |
|-----------------------------|---|---------|----------------------|---------|----------------------|-------|-------|
| | 0-10cm | 10-20cm | 0-10cm | 10-20cm | 0-10 | 10-20 | 20-30 |
| terrace with grass | 0.96 | 0.97 | 26.6 | 26.1 | 23.2 | 23.5 | 24.4 |
| traditional Chinese orchard | 1.05 | 1.08 | 20.1 | 17.1 | 21.1 | 21.9 | 23.4 |
| slope with grass | 0.96 | 0.98 | 27.2 | 25.6 | 23.3 | 23.9 | 24.9 |
| slope without grass | 1.08 | 1.15 | 17.5 | 12.2 | 21.2 | 23.1 | 23.9 |

Table 3. The effect of terrace with grass cultivating manners on soil nutrient contents

| Treatment | PH | O.M. (%) | Total N (%) | Total P (%) | Total K (%) | Available N (mg kg ⁻¹) | Available K (mg kg ⁻¹) |
|----------------------------|------|----------|-------------|-------------|-------------|------------------------------------|------------------------------------|
| Before reclaiming | 5.12 | 1.53 | 0.079 | 0.025 | 2.323 | 95.45 | 100.06 |
| 1y after grass cultivating | 5.40 | 1.69 | 0.090 | 0.027 | 2.152 | 109.59 | 119.79 |
| 2y after grass cultivating | 6.56 | 1.89 | 0.096 | 0.027 | 2.077 | 110.30 | 255.56 |
| 3y after grass cultivating | 6.25 | 1.93 | 0.104 | 0.030 | 1.964 | 120.19 | 253.24 |

Because of the effect of different reclaiming and cultivating manners on soil property and orchard ecology, so the fruit growth was influence. At the beginning stage, the growth of forages cope with fruits for soil water and nutrients, therefore the tree height, trunk diameter and umbriferous area in grass planted orchards were lower than that without forages ones. But after a longer duration, due to the soil nutrients were enhanced by *A. pintoii* so the growth of fruits was improvement. The results showed that after 3 years' incorporated with *A. pintoii*, the citrus tree height, and trunk diameter and umbriferous area in orchards with forage was increased by 9.5%, 8.7% and 18.2% when compared with the orchards without forage. The treatment of terrace with grass is the best among 4 treatments (Table 4). Otherwise, the fruit quality and yield were improvement (Table 5).

Table 4. The effect of different reclaiming and cultivating manners on the fruit trees' growth

| Treatment | Tree height (m) | | Trunk dia. (cm) | | Umbriferous area (m ²) | |
|-----------------------------|-----------------|-----------|-----------------|-----------|------------------------------------|-----------|
| | Jul. 1997 | Mar. 2000 | Jul. 1997 | Mar. 2000 | Jul. 1997 | Mar. 2000 |
| terrace with grass | 1.68 | 3.31 | 1.57 | 2.89 | 1.94 | 6.56 |
| traditional Chinese orchard | 1.78 | 2.82 | 1.67 | 2.68 | 2.19 | 5.64 |
| slope with grass | 1.72 | 2.89 | 1.62 | 2.72 | 2.06 | 5.81 |
| slope without grass | 1.76 | 2.84 | 1.66 | 2.48 | 2.16 | 4.83 |

Table 5. The effect of different and cultivating manners on the fruit quality in 3rd year

| Treatment | Average weight (g per orange) | Average yield (kg per tree) | Acidity (%) | Soluble solid matter (%) | Vitamin C (mg kg ⁻¹) |
|-----------------------------|-------------------------------|-----------------------------|-------------|--------------------------|----------------------------------|
| terrace with grass | 142 | 18.0 | 4.8 | 11.7 | 416.9 |
| traditional Chinese orchard | 163 | 24.7 | 2.9 | 11.9 | 496.2 |

Study on the effect of fresh A. pintoii on feeding meat rabbits

A. pintoii contains 15.88% crude protein, 1.36% crude fate, 29.43% rough cellulose, 0.19% total P, 1.38% total Ca, rich in nutrition and good palatability. Feeding *A. pintoii* to rabbits gets averaged 21.67 g d⁻¹ weight increase which was higher than the treatment of feeding local forages which gets averaged 10.73 g d⁻¹ (Table 6). At ending day, random chose 2 rabbits from every treatment, slaughter percentage result showed that net chamber rate, eye muscle area and muscle and bone ratio was increased by 4.9 %, 46.7 % and 21.6 % in the treatment that feeding with *A. pintoii* + *D. smutsii* when compared with the treatment of feeding with local forage (Table 7). Otherwise, the fruit economic benefit was increased by 194.7 % (Table 8).

Table 6. The effect of different forages on weight gained and feed conversion efficiency of meat rabbit

| Treatment | Starting weight (kg per rabbit) | Ending weight (kg per rabbit) | weight gained (kg per rabbit) | Daily weight gained(g per rabbit) | Feed efficiency |
|---------------------------------------|---------------------------------|-------------------------------|-------------------------------|-----------------------------------|-----------------|
| <i>A. pintoii</i> + <i>D. smutsii</i> | 1.24 | 1.89 | 0.65 | 21.67 | 2.30 |
| local forage | 1.28 | 1.60 | 0.32 | 10.73 | 4.15 |

Table 7. The effect of different forages on slaughter percentage of rabbit

| Treatment | Net chamber rate (%) | Eye muscle area (cm ²) | Meat weight (g per rabbit) | Bone weight (g per rabbit) | Muscle and bone ratio |
|---------------------------------------|----------------------|------------------------------------|----------------------------|----------------------------|-----------------------|
| <i>A. pintoii</i> + <i>D. smutsii</i> | 50.00 | 2.61 | 766.0 | 140.6 | 5.47 |
| local forage | 46.73 | 1.78 | 610.5 | 135.8 | 4.50 |

Table 8. The effect of different forages on economic benefit in feeding rabbit

| Treatment | Daily diet input | | Forage input | | Output | | Benefit (U.S. dollar per rabbit) |
|--------------------------------------|------------------|-------------|--------------|-------------|--------------------|-------------|-------------------------------------|
| | Weight (kg) | U.S. dollar | Weight (kg) | U.S. dollar | Weight gained (kg) | U.S. dollar | |
| <i>A. pintoi</i> + <i>D. smutsii</i> | 1.50 | 0.29 | 10.15 | 0.25 | 0.65 | 1.10 | 0.56 |
| local forage | 1.33 | 0.26 | 7.05 | 0.09 | 0.32 | 0.54 | 0.19 |

Study on the cultivating measures of A. pintoi on red soil

Due to the seeds yield of *A. pintoi* is lower in China, the propagation of *A. pintoi* was based on the asexual, that cutting cultivation. The capacity of regeneration and growth of *A. pintoi* is higher in Fujian province, and its faster growing stage in year round is from May to October, in which time the stem length of *A. pintoi* could be increased from 10cm to 60cm in 4 months. The capacity of ramification of *A. pintoi* is strong too; the growth could up to be 14.7 branches in 6 months. A propriety planting spacing could improve the capacity of ramification of *A. pintoi*. Compared to 10×10cm², the capacity of ramification increased by 30% in 30×30 cm² planting spacing. Temperature, soil fertility and planting spacing are the main facts that affect the growth of *A. pintoi*. Experiments showed that, when spacing distance was 10×10 cm², the cuttings coverage reached 49% on the barren red soil for 30d after cuttaging and planted, 87% for 45d, 91% for 60d; whereas on fertile red soil, cutting coverage reached 80% for 30d. When spacing distance was 20×20 cm², the cutting coverage reached 80% on barren red soil for 75d, but reached 89% on fertile red soil for 75d (Table 9).

Table 9. The effect of different planting space and different soil fertility on coverage density of *A. pintoi*

| Planting space | Coverage density (%) | | | | | | | | | |
|-----------------------|-----------------------------|-----|-----|-----|-----|------------------------------|-----|-----|-----|-----|
| | Barren red soil (O.M. 0.5%) | | | | | Fertile red soil (O.M. 1.5%) | | | | |
| | 30d | 45d | 60d | 75d | 90d | 30d | 45d | 60d | 75d | 90d |
| 10×10cm ² | 49 | 87 | 91 | 97 | 98 | 78 | 94 | 97 | 98 | 99 |
| 20×20 cm ² | 27 | 49 | 64 | 80 | 81 | 41 | 62 | 75 | 89 | 93 |
| 30×30 cm ² | 12 | 20 | 36 | 48 | 57 | 29 | 33 | 57 | 71 | 79 |

Discussion

In the south subtropical area of China, the plants of *A. pintoi* maintain year-round ever-green and bloom. The peak blooming period occurs from May to October, the flower number in each square meter reaches 25-80. Owing to its high sightseeing value of yellow flowers with green leaves, it gradually becomes an ornamental turfgrass and was widely planted in the parks and alongside the highway and possesses high commercial prospect. However, *Arachis pintoi* yields less seeds in China, its multiplication is mainly throughout the asexual propagation. So its planting cost is high, the further international cooperation is needed to promote the popularization of *A. pintoi* cultivation in China.

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