Fruit Tree Identification Based on Multi-source Remote Sensing Image Data—Taking Pomegranate Tree as an Example

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Abstract. In recent years, the development of remote sensing technology systems with medium-high spatial, temporal and spectral resolution is very fast. Remote sensing technology has been widely used in the extraction of feature elements and has achieved good results. If we could identify tree species accurately use remote sensing technology, it will be convenient and efficient to obtain the area of single fruit planting in the investigation of large-scale and multi-variety agricultural products. Then providing guidance for the planning of fruit tree and avoiding expanding planting area blindly according to price trends to bring planting economic benefits. At present, the tree species structure in the fruit growing area is complex, and it is difficult to accurately distinguish a single tree species. The existing extraction method to pomegranate cultivation area is poor effective. Therefore, based on the multi-source remote sensing image and field data, we should preprocess the remote sensing image firstly, then we do the band difference, ratio analysis, spectral index calculation spectral index change tracking, image composite and identification methods co-processing. In the last step we analyse the differences of NDVI values and spectral characteristics of remote sensing images of different tree species in different periods, then we can recognize and extract the pomegranate in fruit tree planting area. The results of the experiment indicate that the method can effectively extract the distribution information of pomegranate trees in complex areas where planting information is available. Thus it can be extended to other crop identification research, which can provide a good reference for the development of precision agriculture and intelligent agriculture management.

1. Introduction

In recent years, remote sensing technology systems with medium-to-high spatial, temporal and spectral resolution have developed rapidly, which provides real-time, fast and accurate acquisition of information about the planting area, planting area and planting structure of various fruit trees in a large fruit area. Provides technical possibilities [1]. With the help of these time-sensitive and high-precision image data, fruit industry authorities at all levels can promptly and effectively guide local fruit farmers to plant, interplant or replace fruit tree species in a timely manner, thereby improving the overall production efficiency of the fruit area; Furthermore, these data information and their updates are the basic spatial-attribute data necessary to establish a regional fruit industry management geographic information system with strong timeliness and high reliability.

With the development of earth observation technology, relevant researchers at home and abroad have successively used space, aviation or ground remote sensing platform data to plant/plant some tree species in the forest, some crops in the cultivated area, or different varieties of a crop, etc. Information
has carried out relatively in-depth monitoring and identification research [2-16]. However, the remote sensing monitoring research on the planting information of the tree species in the fruit area is obviously insufficient: from the small amount of existing research literature, some only use the single-phase data collected on the ground platform to identify a small number of tree species in the fruit area[17-18]. How to use satellite remote sensing images to extract the planting information of pomegranate trees from a large area of fruit areas (especially those with complex planting structures) is the most important thing in remote sensing monitoring of pomegranate trees. Questions such as what the best time is to be answered. In view of this, the author selects the local area of the Guanzhong fruit area (the planting structure of fruit trees is extremely complex, with more than 13 tree species) as the research area and uses domestic remote sensing images with high cost performance, strong timeliness and high resolution to explore. The effective ways and methods of remote sensing identification of pomegranate trees are expected to pave the way for the sound development of pomegranate trees in Guanzhong and even the whole country.

2. Materials and methods

2.1. Introduction of Study Area and Sampling Plot
The study area is located in the central and southern Guanzhong Plain, with latitude and longitude ranging from 34°8′48.44″ -34°45′7.41″N, 108°8′6.33″ -108°59′25.32″E, area It is about 4320km2. The area is located on the Weihe platform, with an average elevation of 650 meters, and the terrain is relatively flat. It belongs to a warm temperate zone with a cool and semi-humid climate, with rain and heat in the same season, with an average annual temperature of 12.96°C, a frost-free period of 214 days, and an average annual rainfall of 537-546mm. The phenological changes of the same fruit trees are almost synchronized. The soil in the area is mainly loess soil.

The area is located in the core section of Guanzhong fruit industry. The fruit industry has an early development history. The planting structure of fruit trees in the area is complex and diverse. At present, there are as many as 12 fruit tree species (including apples, pears, peaches, pomegranates, apricots, grapes, plums, cherries, mulberries, persimmons, walnuts, kiwis, etc.). The pruning methods of the same fruit trees in the area are roughly the same, and the tree shapes are similar. In addition to fruit production in the region, there is also grain production mainly including winter wheat and summer corn. All areas in the region have better irrigation conditions.

Before collecting the reflection spectrum data of fruit trees, based on extensive investigation and familiarity with the details of fruit tree planting in the region, the author selected tree ages that were more than 5 years (calculated according to the collection period of each scene image), and the area was large, length and width Lots larger than 48 meters are used as collection plots. In order to test the interference of winter wheat / summer corn on fruit tree identification, a certain number of plots with large area and planted with winter wheat / summer corn were also selected in the study area.

2.2. Introduction of Image Data Used
All remote sensing images were purchased from China Resources Satellite Application Center. In order to improve the reliability of fruit tree species identification conclusions, this paper uses three sets of image data for analysis and research.

(1) Brief introduction of the first set of image data based on 2015
This set of remote sensing image data is mainly based on the images collected in 2015. The corresponding sensors, acquisition period, spatial resolution and image quality are shown in table 1.
Table 1. Brief introduction of the first set of image data based on 2015.

| sensor   | Image acquisition period | Spatial resolution (m) | Image quality |
|----------|--------------------------|------------------------|---------------|
| GF1_WFV3 | 20140104                 | 16                     | 6             |
| GF1_WFV1 | 20140314                 | 16                     | 6             |
| GF1_WFV2 | 20140322                 | 16                     | 6             |
| GF1_WFV2 | 20140326                 | 16                     | 6             |
| GF1_WFV1 | 20140407                 | 16                     | 6             |
| GF1_WFV3 | 20150428                 | 16                     | 6             |
| GF1_WFV2 | 20150506                 | 16                     | 6             |
| GF1_WFV2 | 20160619                 | 16                     | 6             |
| GF1_WFV3 | 20150719                 | 16                     | 6             |
| GF1_WFV2 | 20150829                 | 16                     | 6             |
| GF1_WFV3 | 20150906                 | 16                     | 6             |
| GF1_WFV3 | 20151001                 | 16                     | 6             |
| GF1_WFV2 | 20151127                 | 16                     | 6             |
| GF1_WFV1 | 20160229                 | 16                     | 6             |

(2) Introduction to the second set of image data mainly in 2016
This set of remote sensing image data is mainly based on the images collected in 2016. The corresponding sensors, acquisition period, spatial resolution and image quality are shown in table 2.

Table 2. Brief introduction of the second set of image data based on 2016.

| sensor   | Image acquisition period | Spatial resolution (m) | Image quality |
|----------|--------------------------|------------------------|---------------|
| GF1_WFV2 | 20160115                 | 16                     | 6             |
| GF1_WFV1 | 20160229                 | 16                     | 6             |
| GF1_WFV2 | 20170308                 | 16                     | 6             |
| GF1_WFV2 | 20160402                 | 16                     | 6             |
| GF1_WFV3 | 20160501                 | 16                     | 6             |
| GF1_WFV2 | 20160619                 | 16                     | 6             |
| GF1_WFV1 | 20160701                 | 16                     | 6             |
| GF1_WFV3 | 20160828                 | 16                     | 6             |
| GF1_WFV3 | 20170912                 | 16                     | 6             |
| GF1_WFV1 | 20161003                 | 16                     | 6             |
| GF1_WFV3 | 20161130                 | 16                     | 6             |

(3) Introduction to the third set of data combined with high spatial resolution images
In order to explore the potential of higher spatial resolution images in pomegranate tree recognition, a third set of images, mainly GF1-PMS images with a spatial resolution of 8 meters, was combined. The images with missing months have a spatial resolution close to 8 ZY3, ZY02C image replacement.
Table 3. The third set of data introductions of high spatial resolution image and image combination.

| sensor      | Image acquisition period | Spatial resolution (m) | Image quality |
|-------------|--------------------------|------------------------|---------------|
| ZY3_MUX     | 20160226                 | 6                      | 6             |
| GF1_PMS2    | 20170325                 | 8                      | 6             |
| GF1_PMS2    | 20170402 (on)            | 8                      | 6             |
| GF1_PMS2    | 20170402 (under)         | 8                      | 6             |
| GF1_PMS2    | 20170427                 | 8                      | 6             |
| GF1_PMS2    | 20150428                 | 8                      | 6             |
| GF1_PMS2    | 20150502 (on)            | 8                      | 6             |
| GF1_PMS2    | 20150502 (under)         | 8                      | 6             |
| GF1_PMS1    | 20160615                 | 8                      | 6             |
| ZY3_MUX     | 20170622                 | 6                      | 6             |
| GF1_PMS1    | 20170722                 | 8                      | 6             |
| GF1_PMS2    | 20150719                 | 8                      | 6             |
| ZY3_MUX     | 20170810                 | 6                      | 6             |
| GF1_PMS1    | 20150829                 | 8                      | 6             |
| GF1_PMS1    | 20150829                 | 8                      | 6             |
| ZY02C_PMS   | 20160908                 | 10                     | 6             |
| GF1_PMS2    | 20161008                 | 8                      | 6             |
| GF1_PMS2    | 20141005                 | 8                      | 6             |
| ZY3_MUX     | 20161103                 | 6                      | 6             |

2.3. Data Processing

2.3.1. Preprocessing of remote sensing image data. Before collecting the reflectance spectrum data of various fruit trees in each period of image, the image of this period is sequentially subjected to image radiation calibration, image mosaic, image space cropping, image atmospheric radiation correction, image geometric correction, mean filtering, and mean value. 7 kinds of preprocessing for filtering and PPI analysis:

2.3.2. Spectral data acquisition. When collecting spectral data in each period of image, reference the PPI image obtained by PPI analysis against the image in this period, in order to collect as many image pixels as possible with high purity. See table 4 for the number of crop plots and the total number of pixels collected for spectral data collection in each image. The collected spectral data of each period is exported in ASCII and imported into different Excel tables (labeled as 0-level tables), and then the data tables of each period are combined into three sets of spectral data by image combination.
### Table 4. Number of collected plots and total number of pixels collected for various crops.

| Crop category       | In each of the first and second sets of images | In each episode of the third set |
|---------------------|------------------------------------------------|----------------------------------|
|                     | Sample plot (Place) | Total number of pixels (±10) | Sampling plot (Place) | Total number of pixels (±10) |
| Apple tree          | 43                 | 540                           | 58                 | 1380                           |
| Peach tree          | 51                 | 830                           | 63                 | 1500                           |
| Crisp pear tree     | 48                 | 950                           | 57                 | 2600                           |
| Grape number        | 67                 | 890                           | 83                 | 2200                           |
| Apricot tree        | 31                 | 580                           | 45                 | 1280                           |
| Plum tree           | 36                 | 650                           | 43                 | 1000                           |
| Pomegranate tree    | 27                 | 440                           | 31                 | 940                            |
| Cherry tree         | 32                 | 630                           | 41                 | 1120                           |
| Kiwi                | 28                 | 330                           | 7                  | 260                            |
| Persimmon tree      | 23                 | 350                           | 8                  | 170                            |
| Walnut tree         | 16                 | 450                           | 9                  | 210                            |
| Winter wheat        | 24                 | 1500                          | 20                 | 3740                           |
| Summer corn         | 18                 | 2030                          | 22                 | 3870                           |

Note: The kiwi, persimmon, walnut, and mulberry trees have fewer plots in the common area of the third set of image data, so the number of plots collected is slightly insufficient.

2.3.3. Processing of collected spectral data. (1) Preprocessing of spectral data For a certain period of spectral data table (level 0 table), first classify all the spectral data by crop species, then average the reflectance of the same crop on the same band, and then the calculation results corresponding to the crops are imported into the same newly created Excel table (labeled as a level 1 table).

According to this method, the same set of spectral data tables are processed separately, and then the export results of each period are sorted into the same more comprehensive Excel table (labeled as a level 2 table) in the order of each period. After preprocessing all the collected spectral data, three Excel data tables (level 2 tables) were finally obtained for subsequent processing.

(2) In order to search for the best identification phase, the best identification spectral index or the most accurate identification method of the pomegranate tree, the author has carried out the following exploratory processing on the three level 2 data tables finally obtained:

- Synchronous spectral data difference calculation
- Differentiation of the same set of consecutive period spectral data
- Calculation of the vegetation index of the contemporaneous spectral data
- Tracking changes of vegetation index in the same set of consecutive periods
- Cooperative processing of spectral data fusion and identification methods

### Table 5. Vegetation index and its calculation formula.
NDVI = (ρ_{NIR} - ρ_{RED}) / (ρ_{NIR} + ρ_{RED})
EVI = 2.5 * \left[\frac{ρ_{NIR} - ρ_{RED}}{ρ_{NIR} + 6ρ_{RED} - 7.5ρ_{BLUE} + 1}\right]
ARVI = \frac{ρ_{NIR} - (2ρ_{RED} - ρ_{BLUE})}{ρ_{NIR} + (2ρ_{RED} - ρ_{BLUE})}
RG = \frac{ρ_{RED}}{ρ_{GREEN}}
Pseudo-CRI1 = \frac{ρ_{GREEN} - ρ_{BLUE}}{ρ_{GREEN} * ρ_{BLUE}}
Pseudo-CRI2 = \frac{ρ_{RED} - ρ_{GREEN}}{ρ_{RED} * ρ_{GREEN}}
Pseudo-ARI2 = \frac{ρ_{NIR} * (2ρ_{RED} + ρ_{BLUE})}{ρ_{RED} * ρ_{GREEN}}
Self-structuring formula 1 = \frac{ρ_{RED} + ρ_{BLUE}}{ρ_{GREEN}}
Self-structuring formula 1 = \frac{ρ_{RED} + ρ_{BLUE}}{ρ_{GREEN} / NDVI}

Note: Where \(ρ\) is the reflectance, \(ρ_{NIR}\), \(ρ_{RED}\), \(ρ_{GREEN}\), and \(ρ_{BLUE}\) are the reflectances in the near-infrared, red, green, and blue bands, respectively.

3. Results and analysis

3.1. Results and Analysis of Three Sets of Data Calculations

After using the above-mentioned various data processing methods to calculate and compare the collected fruit tree reflection spectrum data, we can know the identification method and approach of kiwi:

1. The difference between the NDVI values of various fruit trees in July and the respective NDVI values at the end of November. The difference between the kiwi, persimmon tree and walnut tree is the largest, because the leaves of these three fruit trees fall earlier in November. According to this rule, all fruit trees can be divided into two categories: kiwi, persimmon tree, and walnut tree as a large category, and other fruit trees including pomegranate as another category.

2. In the class consisting of other fruit trees including pomegranate, the peach tree and grapevine can be distinguished first. The following rules can be used to distinguish peach trees from the same type of fruit trees: 1) The peach tree has the highest NDVI value at the beginning of October to clearly distinguish it from the NDVI values of other fruit trees and summer corn; 2) the beginning of April (Flowering season), the spectral index \((r + b) / g / ndvi\) of the peach tree has a relatively high value.

The following rules can be used to distinguish grapevines from other fruit trees: 1) From mid-April to early May, the NDVI value of the vine is relatively small, because the upper branches of the vine are trimmed in winter and spring Cut off, leaving only short branches of about 20 cm. This phenomenon is caused by the late germination of grape branches after the beginning of spring. 2) The sum of the reflectance of each band of the vine in June is higher than that of other fruit trees. Using the above rules, can distinguish vines from 12 fruit trees

3. In this way, all fruit trees are divided into four categories: peach trees are first category, grapes are second category, kiwi, walnut and persimmon trees are third category, and other fruit trees including pomegranates are fourth category.

4. Among other fruit trees, including pomegranates, in the fourth category, pomegranates can be distinguished according to the following rules: From early April to mid-June, the NDVI value of the pomegranate is the smallest. The reason is that pomegranates belong to shrubs. Fruit trees have relatively small NDVI values due to their small foliage and few thin branches.

3.2. Band Sum Results and Analysis

(1) The first set of data verification

Table 6. NDVI data calculated from the first set of data.

| Image acquisition period | Crisp pear tree | Cherry tree | Peach tree | Apple tree | apricot | Plum tree |
|--------------------------|----------------|-------------|------------|------------|---------|-----------|

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As can be seen from the above chart, the NDVI values of kiwi, persimmon tree and walnut tree are relatively low at the end of November, and their NDVI values are: 0.2313; 0.1483; 0.1438 while the NDVI values of other fruit trees are peach 0.7039; crisp pear tree 0.3607; apple Tree 0.3860; apricot tree 0.5172; plum tree 0.6046; grapevine 0.2597; mulberry tree 0.3216; pomegranate tree 0.3072; wheat 0.4398; cherry tree 0.3376

| Grapevine   | mulberry | Pomegranate tree | Persimmon tree | Kiwi tree | wheat | Walnut tree |
|-------------|----------|------------------|---------------|-----------|-------|------------|
| 0.1093      | 0.1554   | 0.1063           | 0.1013        | 0.0875    | 0.3939| 0.0812     |
| 0.2298      | 0.3227   | 0.2400           | 0.2400        | 0.2468    | 0.6631| 0.2215     |
| 0.1834      | 0.6165   | 0.5413           | 0.4123        | 0.4840    | 0.7250| 0.4374     |
| 0.1998      | 0.5872   | 0.4906           | 0.3711        | 0.4383    | 0.6156| 0.4013     |
| 0.5183      | 0.2860   | 0.4350           | 0.3333        | 0.5958    | 0.1007| 0.4066     |
| 0.6459      | 0.2949   | 0.6407           | 0.7201        | 0.6142    | 0.4802| 0.7531     |
| 0.4808      | 0.5020   | 0.5187           | 0.6071        | 0.5540    | 0.6106| 0.6068     |
| 0.6412      | 0.5975   | 0.7005           | 0.6968        | 0.6594    | 0.7405| 0.6949     |
| 0.5225      | 0.5207   | 0.5385           | 0.4775        | 0.5337    | 0.3120| 0.5515     |
| 0.2597      | 0.3216   | 0.3072           | 0.1438        | 0.2313    | 0.4398| 0.1438     |
| 0.3096      | 0.3721   | 0.3672           | 0.3601        | 0.2762    | 0.4992| 0.3449     |
Figure 1. NDVI data calculated from the first set of data.

(2) The second set of data verification:

| Image acquisition period | Kiwi tree | mulberry tree | Cherry tree | Walnut tree | Apple tree | wheat |
|--------------------------|-----------|---------------|-------------|-------------|------------|-------|
| 20160229                 | 0.0875    | 0.1493        | 0.1633      | 0.0795      | 0.1513     | 0.4079 |
| 20170308                 | 0.1864    | 0.2523        | 0.2310      | 0.2058      | 0.2797     | 0.6147 |
| 20160402                 | 0.0846    | 0.2190        | 0.1787      | 0.1463      | 0.2120     | 0.4478 |
| 20170414                 | 0.3322    | 0.4296        | 0.4443      | 0.4707      | 0.4707     | 0.6929 |
| 20160501                 | 0.5056    | 0.5722        | 0.5681      | 0.4817      | 0.6329     | 0.6941 |
| 20160619                 | 0.5958    | 0.2827        | 0.6419      | 0.4067      | 0.5673     | 0.1005 |
| 20160717                 | 0.6778    | 0.2339        | 0.6318      | 0.5673      | 0.6936     | 0.3187 |
| 20160828                 | 0.6537    | 0.5413        | 0.5829      | 0.6729      | 0.6840     | 0.7459 |
| 20160903                 | 0.3598    | 0.4339        | 0.4884      | 0.5107      | 0.5963     | 0.1958 |
| 20161110                 | 0.2668    | 0.3251        | 0.3319      | 0.1981      | 0.4465     | 0.5581 |

| Plum tree     | Persimmon tree | Pomegranate tree | Grapevine | apricot | Peach tree | Crisp pear tree |
|---------------|----------------|------------------|-----------|---------|------------|-----------------|
| 0.1624        | 0.1013         | 0.1063           | 0.1093    | 0.1490  | 0.1646     | 0.1452          |
| 0.2526        | 0.2648         | 0.2030           | 0.1955    | 0.2556  | 0.2200     | 0.2700          |
| 0.1905        | 0.1603         | 0.1411           | 0.1145    | 0.2012  | 0.1887     | 0.1763          |
| 0.4138        | 0.4358         | 0.3067           | 0.2092    | 0.5099  | 0.2852     | 0.4522          |
| 0.6714        | 0.2694         | 0.4648           | 0.1999    | 0.6615  | 0.4590     | 0.6370          |
| 0.6154        | 0.3333         | 0.3818           | 0.5183    | 0.4618  | 0.5200     | 0.5500          |
| 0.7479        | 0.6207         | 0.5423           | 0.6089    | 0.6314  | 0.6721     | 0.6629          |
| 0.7043        | 0.5607         | 0.5559           | 0.5442    | 0.6808  | 0.7194     | 0.6580          |
| 0.6444        | 0.4487         | 0.5431           | 0.4784    | 0.5622  | 0.6457     | 0.6056          |
| 0.3940        | 0.1953         | 0.2326           | 0.2068    | 0.3239  | 0.3903     | 0.3889          |
As can be seen from the above chart, the NDVI values of kiwi, persimmon and walnut trees are relatively low at the end of November, and their NDVI values are: 0.2668; 0.1935; 0.1981, while the NDVI values of other fruit trees are mulberry 0.3251 and cherry tree 0.3319 Apple tree 0.4465; wheat 0.5581; plum tree 0.3940; pomegranate 0.2326; grape vine 0.2068; apricot tree 0.3239; peach tree 0.3903; crisp pear tree 0.3899.

(3) The third set of data verification

Table 8. NDVI data calculated from the third set of data.

| Image acquisition period | Plum tree | Peach tree | Crisp pear tree | Apple tree |
|--------------------------|-----------|------------|-----------------|------------|
| 2.26                     | 0.1906    | 0.1646     | 0.1938          | 0.1903     |
| 3.25                     | 0.2931    | 0.2162     | 0.2840          | 0.2643     |
| 4.2                      | 0.2916    | 0.2162     | 0.2840          | 0.2643     |
| 4.27                     | 0.6487    | 0.2336     | 0.2868          | 0.2936     |
| 5.2                      | 0.6781    | 0.5926     | 0.6730          | 0.7250     |
| 6.19                     | 0.6920    | 0.7065     | 0.6802          | 0.7295     |
| 7.18                     | 0.7437    | 0.7654     | 0.6859          | 0.7423     |
| 8.29                     | 0.6304    | 0.6862     | 0.6905          | 0.6818     |
| 9.8                      | 0.7367    | 0.7821     | 0.6662          | 0.7181     |
| 10.5                     | 0.7235    | 0.7948     | 0.7194          | 0.6071     |

| Grapevine | apricot | Cherry tree | Pomegranate tree |
|-----------|---------|-------------|------------------|
| 0.1160    | 0.1617  | 0.1911      | 0.1664           |
| 0.2013    | 0.2221  | 0.1528      | 0.1920           |
| 0.1996    | 0.2543  | 0.2191      | 0.2300           |
| 0.2500    | 0.6396  | 0.6025      | 0.5698           |
| 0.3368    | 0.6676  | 0.6368      | 0.6276           |
| 0.6015    | 0.6076  | 0.6507      | 0.5686           |
| 0.6979    | 0.7507  | 0.7079      | 0.6802           |
| 0.6000    | 0.6084  | 0.6057      | 0.6148           |
| 0.6106    | 0.6828  | 0.6180      | 0.6637           |
| 0.5746    | 0.7408  | 0.6629      | 0.7330           |
In the category of other fruit trees including pomegranate, peach trees can be distinguished from this category by using the following rules: 1) At the beginning of October, peach trees have the highest NDVI value, which is different from other fruit trees and corn NDVI values are significantly different; 2) At the beginning of April (the peach blossom season), the spectral index (\( r + b \) / \( g \) / \( ndvi \)) of the peach tree has a relatively high value.

The following rules can be used to distinguish grapes from other fruit trees: 1) From mid-April to early May, the NDVI value of the vine is relatively small, because the upper branches of the vine are trimmed in winter and spring Cut off, leaving only short branches of about 20 cm. This phenomenon is caused by the late germination of grape branches after the beginning of spring. 2) The sum of the reflectance of each band of the vine in June is higher than that of other fruit trees. Using the above rules, can distinguish vines from 12 fruit trees.

### 3.3. Identification of The Pomegranate Tree

Among other fruit trees including pomegranate, the fourth category (except peach trees and grapevines) can be used to distinguish pomegranates according to the following rules: From early April to mid-June, the average NDVI of pomegranate is the smallest. The reason is It is a shrub fruit tree belonging to the pomegranate. Its leaf surface is small and the number of thin branches is small, which results in its relatively minimum NDVI value.

**Table 9.** Average NDVI calculated from the end of April to mid-June for the first set of date.

| Image acquisition period | Pomegranate tree | Apple tree | mulberry |
|--------------------------|------------------|------------|----------|
| 20150428                 | 0.5413           | 0.6594     | 0.6166   |
| 20150506                 | 0.4906           | 0.6044     | 0.5873   |
| 20160619                 | 0.4350           | 0.5877     | 0.2861   |
| Three-valued average     | 0.4890           | 0.6172     | 0.4966   |
| apricot                  | 0.6786           | 0.6932     | 0.6455   | 0.6396   |
|                           | 0.5953           | 0.6056     | 0.5662   | 0.5646   |
|                           | 0.4618           | 0.6154     | 0.5501   | 0.5519   |
|                           | 0.5786           | 0.6381     | 0.5873   | 0.5854   |

**Table 10.** Average NDVI calculated from the end of April to mid-June in the second set of data.

| Image acquisition | mulberry | Cherry tree | Crisp pear tree | Apple tree |
|-------------------|----------|-------------|-----------------|-----------|

Figure 3. NDVI data calculated from the third set of data.
As can be seen from the above table, among the large categories (except peach trees and grapes) composed of other fruit trees including pomegranates, pomegranates can be distinguished according to the following rules: from early April to mid June, the average NDVI of pomegranate The smallest reason is that the pomegranate belongs to the shrub fruit tree. Its leaf surface is small and the number of thin branches is small, which results in its relatively lowest NDVI value.

4. Conclusion and discussion

4.1. Conclusion
Based on the remote sensing image data, this paper takes several fruit tree species (peach, pomegranate, cherry, kiwi, mulberry, etc.) planted in Liquan County as research objects. Based on the NDVI values of various fruit trees obtained in different months Identify the pomegranate tree according to the rules, and get the following conclusions:

After the above-mentioned various data processing methods are used to calculate and compare the collected fruit tree reflection spectrum data, we can know the kiwi fruit identification method and approach: (1) the NDVI value of various fruit trees in July Poor, the difference between kiwi, persimmon tree and walnut tree is the largest. According to this rule, all fruit trees can be divided into two categories: kiwi, persimmon tree, and walnut tree are a large group, and other fruit trees including pomegranate are other one type. (2) In the class consisting of other fruit trees including pomegranate, the peach tree and grapevine can be distinguished first. The following rules can be used to distinguish peach trees from the same type of fruit trees: 1) The peach tree has the highest NDVI value at the beginning of October to clearly distinguish it from the NDVI values of other fruit trees and summer corn; 2) the beginning of April (the peach tree Flowering season), the peach tree's spectral index (R + B) / G / NDAI has a relatively high value. The following rules can be used to distinguish grapes from other fruit trees: 1) From mid-April to early May, the NDVI value of the grapevine is relatively small. 2) In June, the sum of the reflectance of each band of the grape vine is higher than that of other fruit trees. Using the above rules, 12 kinds of fruit trees of the grape grove can be identified. (3) In this way, all fruit trees are divided into four categories: peach trees are the first category, grape flavor is the second category, kiwi, walnut and persimmon trees are the third category, and other fruit trees including pomegranates are the fourth category. (4) Among other fruit trees including pomegranates, which are in the fourth category, pomegranates can be distinguished according to the following rules: from early April to mid-June, the pomegranate has the lowest NDVI value.

4.2. Discussion
This paper uses remote sensing image data to identify fruit tree species in Liquan County, Xianyang City. However, due to the limited amount of data obtained during the research process, further research and exploration are needed to obtain a more accurate identification method.

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