Investigation on Weeds in Vegetable Fields in the Northern Suburbs of Meizhou City, South China

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Abstract. There were a total of 81 weed species in the northern suburbs of Meizhou, belonging to 34 families and 71 genera, and most of them were dicotyledons. Asteraceae and Gramineae were the dominant families. The genera were mainly distributed in the tropical zone, accounting for 71.83% of the total species, with a strong tropical. The short-lived weeds in the first and second year accounts for 53.09% of the total species, and there were more annual weeds. From the light intensity adaptability point of view, these vegetable weeds were dominated by light-demanding and shade-tolerant plants. From the standpoint of water adaptability, most of them were mesophytes. Weeds with a high degree of damage to vegetable crops were usually herbs, meeting the R countermeasures, having strong ecological adaptability, strong reproduction ability, and high competitiveness, and can spread rapidly in the wild. In addition, a total of 19 alien invasive species were found in this weed community, with the largest number in the Asteraceae family and most originating from tropical America. Among them, Alternanthera philoxeroides, Wedelia trilobata, etc. can form a single superior community, causing great harm. These weeds have strong resistance to herbicides, insecticides, domestic sewage, etc., so how to control them is still a difficult problem.

Weeds refer to all herbs or subshrubs that are unfavorable to human activities or harmful to production sites. They are a class of highly evolved plant groups under the pressure of both human and natural selection (Li et al., 2013; Fang, 2013). There are over 300,000 plant species named globally, among which about 8000 species are considered weeds (Liang and Qiang, 2014). More than 36,000 plants were found in the records of books and periodicals in China, among them, there are about 1200 weed species belonging to 119 families. Compared with all kinds of crops planted by humans, weeds have strong resistance to stress (Fang, 2013; Fu, 2014). These characteristics make them easy to compete with crops for water, nutrients, light and living space. They cause serious harm to crops, reduce their yield and quality, and finally bring great economic losses to humans. In addition, the pollen or seeds of some weeds, such as Ambrosia artemisiifolia, contain toxins that can poison humans, animals and endanger their health. As a result, the integrated control of weeds has become the focus of scientific research. Vegetable field weeds are always important factors to improve the yield and quality of vegetable crops; they are often entangled with vegetables, which lead to the difficulty of manual extraction. In addition, some weeds are also the intermediate hosts of diseases and pests of vegetable crops such as whitefly (Trialeurodes vaporariorum), aphid, and spot hidden fly (Liriomyza maculata), which cause serious harm to various vegetable crops planted in vegetable fields (Fu, 2014). In this paper, the species composition, floristic origin, life type, light intensity adaptation and water adaptation ecological type of vegetable field weeds in the northern suburb of Meizhou were studied by field survey, literature review and statistical analysis. This paper summarizes the characteristics of weed
communities and damage in vegetable field in northern suburb of Meizhou City, and provides scientific basis for the comprehensive control of weeds in vegetable fields in South China.

1. The General Situation of the Studied Area and Survey Methods

The vegetable fields under investigation is located in the northern suburb of Meizhou City, North-eastern Guangdong Province, South China (116°8'17''E, 24°20'17''N). The climate type is subtropical monsoon, where enjoys a warm and humid subtropical monsoon climate. The average elevation is about 92.6m, temperature is 20.6~21.4°C, annual sunshine duration is 1714.6~2010.5 h, rainy days are about 150 d, annual rainfall is 1483.4~1798.4 mm, 75% of which concentrated in months from Apr. to Sept., and the frost-free period is about 309 d. The rainy season is mainly from April to September. The soil is mostly red loam, its pH value of red loam soil is 4.5-6.8, which is slightly acidic.

2. Results

2.1. Species Composition of Weeds

Through the investigation in the vegetable fields, 81 weeds were found, belonging to 71 genera and 34 families. Among the 81 weeds, there were only 3 species of ferns, belonging to 3 genera and 3 families, accounting for 3.70% of total species, 4.22% of total genera, and 8.82% of the total families respectively. They were *Cercis chinensis*, *Dryopteris chinensis* and *Pteris vittata* respectively. There were 13 species of monocotyledons belonging to 12 genera and 4 families, which account for 16.05% of the total species, 16.90% of the total genera and 11.76% of the total families, which include *Miscanthus floridulus*, *Digitaria sanguinalis*, *Eleusine indica*, *Leptochloa chinensis*, *Kyllinga brevifolia*, *Paspalum thunbergii*, *Setaria viridis*, *Commelina communis*, etc. Dicotyledons, 65 Species, 56 genera, 27 families, which account for 80.25% of the total species, 78.87% of genera, 79.41% of families, such as *Alternanthera philoxeroides*, *Gonostegia hirta*, *Phyllanthus urinaria*, *Anemone hupehensis*, *Fouzolzia zeylanica*, *Conyza canadensis*, *Bidens pilosa*, *Lysimachia alfredii*, *Crassocephalum crepidioides*, *Siegesbeckia orientalis*, *Spilanthes paniculata*, *Amaranthus spinosus*, *Ipomoea cairica*, etc. The majority of weeds in the vegetable fields are dicotyledons, followed by monocotyledons, and very few are ferns, indicating that dicotyledons are the dominant group of weeds in the vegetable fields.

There were abundant weeds in the vegetable fields, and the number of species in each family varied greatly. Among the 34 weed families, 19 families contain only one weed. They were *Primulaceae*, *Plantaginaceae*, *Tiliaceae*, *Pteridaceae*, *Cucurbitaceae*, *Thelypteridaceae*, *Malvaceae*, *Crassulaceae*, *Onagraceae*, *Portulacaceae*, *Equisetaceae*, *Vitaceae*, *Thymelaeaceae*, *Guttiferae*, *Amaranthaceae*, and the most dominant family containing more than 10 species was the *Compositae* (14).

The dominant families of weeds in the vegetable fields are defined as the family containing over 5 weed species. There were 4 families, which are *Euphorbiaceae*, *Gramineae*, *Compositae* and *Amaranaceae*, which account for 11.76% of the total families, including 35 species and 30 genera of weeds, which account for 42.25% of the total genera and 43.21% of total species respectively, which showed that the weeds of the aforementioned 4 families were the main weeds in the vegetable fields. Among these dominant families, *Compositae* and *Gramineae* were the first and second dominant family, containing 23 species belonging to 23 genera, which accounted for 32.39% of the total genera and 28.40% of total species, and was also a widely distributed weed in the world. The individual number of *Compositae* and *Gramineae* were usually the most in the relatively arid regions, but in the area near water, those of *Cyperaceae* and *Amaranthaceae* tended to be...
more than those of the two families mentioned above.

2.2. Floristic Composition of Weeds

According to distribution types of the genus of spermatophyte and pteridophyte propose by Wu (1991) and Lu (2004), 71 genera of these weeds in the vegetable fields were analyzed (Table 1). There were 51 genera in the tropical distribution type, 34 genera in the pantropical distribution type, which accounted for the largest proportion in the weeds and reached 47.89% of the total genera. Among them, the genus of angiosperms included *Setaria*, *Cynodon*, *Cenchrus*, *Leptochloa*, *Paspalum*, *Eleusine*, *Kyllinga*, *Commelina*, *Conyza*, *Euphorbia*, *Clerodendrum*, *Ludwigia*, *Hedyotis*, *Ipomoea*, *Borreria*, *Corchorus*, *Centella*, *Spilanthes*, *Pilea*, *Eclipta*, *Alternanthera*, *Portulaca*, *Achyranthes*, *Wedelia*, *Pharbitis*, *Celosia*, *Hydrocotyle*, *Acalypha*, *Siegesbeckia*, *Phyllanthus*, *Mimosa*, *Pouzolzia*, and the genus of pteridophyte included *Pteris*, *Cyclosorus*. There were all 4 genera in old world tropical distribution type, tropical Asia to tropical Oceania type, tropical Asia (Indo-Malaysia) types, which accounted for 5.63% of the total genera respectively. The old world tropical distribution type included *Zehneria*, *Abelmoschus*, *Cayratia* and *Emilia*; the tropical Asia to tropical Oceania distribution type included *Lophatherum*, *Epimeredi*, *Wikstroemia* and *Mazus*; the tropical Asia distribution type included *Typhonium*, *Pueraria*, *Ixeris* and *Gonostegia*. There were 3 genera in tropical Asia and tropical America distribution type, which accounted for 4.23% of the total genera and included *Ageratum*, *Scoparia* and *Parthenium*. But there were only 2 genera in tropical Asia to tropical Africa distribution type, namely *Miscanthus* and *Crassocephalum*, which accounted for 2.82% of the total genera.

In addition to the tropical type, the most common type is the world distribution. There were 15 genera, accounting for 21.13% of the total genera, including *Digitaria*, *Cyperus*, *Plantago*, *Bidens*, *Rorippa*, *Hypericum*, *Polygonum*, *Galinsoga*, *Solamun*, *Salvia*, *Cardamine*, *Amaranthus*, *Lysimachia*, *Oxalis*, all of which belonged to angiosperms. The third was the north temperate distribution type, which included 5 genera and accounted for 7.04%, which was *Equisetum* of pteridophyta, and *Artemisia*, *Seriphidium*, *Capsella*, *Aster* and *Sedum* of angiosperm. This weed community was rich in species and complex in geographical composition, and dominated by tropical distribution type which included 51 genera of the total genera and accounted for 71.83% of the total genera, so the flora of the vegetable fields had a strong tropical characteristics.

| Distribution type | Number of genera | Percentage % |
|-------------------|------------------|--------------|
| 1. World/Cosmopolitan | 15 | 21.13 |
| 2. Pantropical distribution/Pantropic | 34 | 47.89 |
| 3. Tropical Asia and tropical America discontinuous distribution/Tropical Asia and Tropical America disjunct | 3 | 4.23 |
| 4. Old World Tropic | 4 | 5.63 |
| 5. Tropical Asia to tropical Oceania distribution/Tropical Asia and Tropical Australasia | 4 | 5.63 |
| 6. Tropical Asia to tropical Africa/Tropical Asia to Tropical Africa | 2 | 2.82 |
| 7. Tropical Asia (Indo-Malaysia) | 4 | 5.63 |
| 8. North Temperate | 5 | 7.04 |
| Total | 71 | 100 |

2.3. Life form Composition of Weeds

For plants, their life forms are the types of vegetation which can be reflected by their appearance because of their long-term adaptation to the comprehensive environmental conditions (Yang et al., 2015; Huai et al., 2003). The weed life forms in these vegetable fields are classified into three types: annual, biennial and perennial. The statistical results are shown in Fig. 1.
There were 37 annual weeds belonging to 15 families, accounting for 45.68% of the total species, including *Commelina communis*, *Phyllanthus urinaria*, *Digitaria sanguinalis*, *Conyza canadensis*, *Bidens pilosa*, *Polygonum hydropiper*, *Conyza canadensis*, *Bidens pilosa*, *Polygonum aviculare*, *Eclipta prostrata*, *Acalypha australis*, *Mazus japonicus*, *Cenchrus echinatus*, *Parthenium hysterophorus*, *Euphorbia hirta*, *Euphorbia thymifolia*, *Leptochloa chinensis*, *Borreria stricta*, *Celosia argentea*, *Solanum nigrum* var. *pauciflorum*, *Pharbitis nil*, *Galinsoga parviflora*, *Hedyotis diffusa*, *Cardamine hirsuta*, *Hypericum japonicum* and *Emilia sonchifolia*. There were only 6 species of biennial weeds belonging to 4 families, accounting for 7.41% of the total species number of weeds. They were *Abelmoschus moschatus*, *Salvia plebeia*, *Capsella bursa-pastoris*, *Rorippa indica*, *Plantago depressa* and *Epimeredi indica* respectively.

There were 38 perennial weeds belonging to 25 families, accounting for 46.91% of total species. They were *Alternanthera philoxeroides*, *Miscanthus floridulus*, *Gonostegia hirta*, *Anemone hupehensis*, *Pouzolzia zeylanica*, *Setaria viridis*, *Clerodendrum kwangtungense*, *Aster tataricus*, *Lysimachia alfredii*, *Kyllinga brevifolia*, *Anemone hupehensis*, *Paspalum thunbergii*, *Wedelia trilobata*, *Artemisia argyi*, *Cyperus rotundus*, *Ipomoea cairica*, *Oxalis corniculata*, *Pteris vittata*, *Solanum torvum*, *Scoparia dulcis*, *Lophatherum gracile*, *Centella asiatica*, *Hydrocotyle sibthorpioides*, *Ludwigia octovalvis*, *Oxalis corymbosa*, *I sonrası indica*, *Wikstroemia indica*, *Mimosa pudica*, *Equisetum ramosissimum*, *Cyclosorus parasticus*, *Typhonium divaricatum*, *Sedum emarginatum*, *Euphorbia esula*, *Zehneria indica*, *Cayratia japonica*, *Hedysotis auriculata* and *Pueraria lobata*.

Among these weeds in the vegetable fields, the annual and biannual species accounted for 53.09% of total species, which was slightly more than the perennial species. Their seed germination rate is high, seedlings grow fast, young period of plants is short and mature quickly, so they can be successfully domesticated and constructed (Ma, 2013; Guo and Wang, 2009) such as *Conyza canadensis*, *Eleusine indica* and *Digitaria sanguinalis*. The proportion of annual plants increases with the increase of human activity, which is closely related to the high intensity and high frequency of human disturbance in vegetable fields. The perennial weeds usually have strong asexual reproduction ability, causing vegetable soil to flip, and the fragmentation of nutrients does not affect the survival of the species.
2.4. Light Intensity Adaptation Ecological Types of Weeds
According to the different requirements for light intensity, they are divided into three categories: light-demanding plants, shade plants and shade tolerant plants (Qiang, 2010). The statistical results of ecological types of adaptation to light intensity of these weed communities are shown in Table 2. In the vegetable fields, the shade tolerant plants were the most, there were 47 species belonging to 26 families, accounting for 58.02% of the total species in the vegetable fields. They were *Anemone hupehensis*, *Pouzolzia zeylanica*, *Clerodendrum kwangtungense*, *Aster tataricus*, *Eclipta prostrata*, *Kyllinga brevifolia*, *Achyranthes aspera*, *Alternanthera philoxeroides*, *A. sessilis*, *Pteris viitata*, *Solanum torvum*, *S. nigrum*, *S. nigrum var. pauciflorum*, *Lophatherum gracile*, *Centella asiatica*, *Hydrocotyle sibthorpioides*, *Wikstroemia indica*, *Mimosa pudica*, *Equisetum ramosissimum*, *Sedum emarginatum*, *Euphorbia esula*, *Zehneria indica*, *Cayratia japonica*, *Hedyotis auriculata*, *Capsella bursa-pastoris*, *Rorippa indica*, *Commelina communis*, *Phyllanthus urinaria*, *Bidens pilosa*, *Polygonum hydropiper*, *P. aviculare*, *Crassocephalum crepidoideae*, *Siegesbeckia orientalis*, *Sipanthes paniculata*, *Amaranthus lividus*, *Pilea microphylla*, *Acalypha australis*, *Mazus japonicus*, *Galinsoga parviflora*, *Hedyotis diffusa*, *Cardamine hirsuta*, *Hypericum japonicum*, *Euphorbia thymifolia*, *Gonostegia hirta*, *Oxalis corniculata*, *O. corymbosa*, *Lysimachia alfredii*, *Cenchrus echinatus*, *Acalypha australis*, *Euphorbia hirta*, *Leptochloa chinensis*, *Borreria stricta*, *Cyperus rotundus*, *Eclipta prostrata*, *Parthenium hysterophorus*, *Euphorbia hirta*, *Leptochloa chinensis*, *Borreria stricta*, *Citrus argentea*, *Pharbitis nil* and *Emilia sonchifolia*. There were only 2 species of relatively typical shade-demanding plants belonging to 2 families, accounting for 2.47%, which were *Cyclosorus parasiticus* and *Typhonium divaricatum*.

Table 2. Analysis of light intensity adaptation ecological type composition of weeds in vegetable fields

| Light intensity adaptation ecological type | Light-demanding plant | Shade plant | Shade tolerant plant |
|-------------------------------------------|-----------------------|-------------|---------------------|
| Species number                            | 32                    | 2           | 47                  |
| Percentage of total species/%             | 39.51                 | 2.47        | 58.02               |

The weed community in the vegetable fields was dominated by light-demanding plants, followed by shade tolerant plants, and the typical shade plants were rare. This is because shade plants require wetter habitats and can grow well under lower light intensity, while most parts of the vegetable fields can not provide suitable conditions for their good growth and development.

2.5. Water Adaptation Ecological Types of Weeds
According to the water condition of habitat, plants can be divided into aquatic plants and terrestrial plants, and the terrestrial plants can be divided into three types: xerophyte, hygrophyte and mesophyte (Sun et al., 2016). As the weeds in the vegetable fields could be classified into three types: xerophyte, hygrophyte and mesophyte. The statistical results are shown in Table 4. In this weed community, there were 9 hygrophytes belonging to 7 families, which accounted for 11.11% of the total species and included *Commelina communis*, *Polygonum hydropiper*, *Pouzolzia zeylanica*, *Ludwigia octovalvis*, *Centella asiatica*, *Centipede brevifolia*, *Hydrocotyle sibthorpioides*, and *Pilea microphylla* and *Equisetum ramosissimum*. The other 72 weeds all were mesophytes belonging to 29 families, which accounted for 88.89%, such as *Micanthus floridulus*, *Cynodon dactylon*, *Digitaria sanguinalis*, *Setaria viridis*, *Epimeredi indica*, *Oxalis corniculata*, *Lysimachia alfredii*, *Bidens pilosa*, *Polygonum hydropiper*, *P. aviculare*, *Crassocephalum crepidoideae*, *Siegesbeckia orientalis*, *Sipanthes paniculata*, *Amaranthus lividus*, *Pilea microphylla*, *Acalypha australis*, *Mazus japonicus*, *Galinsoga parviflora*, *Hedyotis diffusa*, *Cardamine hirsuta*, *Hypericum japonicum*, *Euphorbia thymifolia*, *Gonostegia hirta*, *Oxalis corniculata*, *O. corymbosa*, *Lysimachia alfredii*, *Cenchrus echinatus*, *Acalypha australis*, *Euphorbia hirta*, *Leptochloa chinensis*, *Borreria stricta*, *Cyperus rotundus*, *Eclipta prostrata*, *Parthenium hysterophorus*, *Euphorbia hirta*, *Leptochloa chinensis*, *Borreria stricta*, *Citrus argentea*, *Pharbitis nil* and *Emilia sonchifolia*. There were only 2 species of relatively typical shade-demanding plants belonging to 2 families, accounting for 2.47%, which were *Cyclosorus parasiticus* and *Typhonium divaricatum*. 

![Image of Table 2](image-url)
Typhonium divaricatum, Commelina communis, Lysimachia alfredii, Plantago depressa and Salvia plebeia.

The weed community in the vegetable fields was obviously dominated by mesophytes, which was nearly 90% of the total species, and accords with the water supply situation under most vegetable habitats, mesophytes grow more luxuriantly than hygrophytes.

Table 3. Water-adapted ecotype composition analysis of weeds in vegetable fields

| Water adaptation ecological type | Xerophyte | Hygrophyte | Mesophyte |
|---------------------------------|-----------|------------|-----------|
| Species number                  | 0         | 9          | 72        |
| Percentage of total species%    | 0         | 11.11      | 88.89     |

2.6. Harm Degree of Weeds to Vegetables

By competing with crops for water, nutrients and light energy, weeds, thus affect the yield and quality of crops and cause economic losses (Guo and Wang, 2009). Through field investigation and statistics on weeds in the vegetable fields, according to the frequency and quantity of weeds, the harm degree of weeds to vegetable crops was divided into four grades: very serious, serious, moderate and slight (Fig. 2).

In this weed community, there were very seriously harmful 11 weeds belonging to 7 families, which accounted for 13.58% of the total species. They were Miscanthus floridulus, Commelina communis, Cynodon dactylon, Digitaria sanguinalis, Alternanthera philoxeroides, Gonostegia hirta, Phyllanthus urinaria, Anemone hupehensis, Pouzolzia zeylanica, Conyza canadensis, and Bidens pilosa. These weeds are herbaceous, widely distributed and adaptable. They were composed of annual and perennial weeds. Most of the annual weeds had short life cycle, fast growth, seed propagation, long flowering and fruiting period, and strong fecundity, such as Digitaria sanguinalis. Most perennial weeds had strong asexual reproduction, rapid diffusion and strong viability, such as Cynodon dactylon.

There were 27 seriously harmful weeds belonging to 14 families, which accounted for 33.33% of total species, including Kyllinga brevifolia, Setaria viridis, Paspalum thunbergii, Eleusine indica, Cyperus rotundus, Pteris vittata, Polygonum hydropiper, Solanum nigrum var. pauciflorum, Clerodendrum kwangtungense, Aster tataricus, Lysimachia alfredii, Crassocephalum crepidoideae, Siegesbeckia orientalis, Spilanthes paniculata, Achyranthes aspera, Alternanthera sessilis, Amaranthus lividus, Euphorbia hypericifolia, Abelmoschus moschatus, Wedelia trilobata, Agretum conyzaoides, Artemisia argyi, Portulaca oleracea, Amaranthus spinosus, Ipomoea cairica, Oxalis corniculata and Cenchrus echinatus. These weeds usually grow quickly, has strong fecundity and strong adaptability, so they widely distribute and are common weeds in orchard and vegetable fields.

28 moderate harmful weeds belonging to 20 families accounted for 34.57% of total species. There were Lophatherum gracile, Leptochloa chinensis, Cyclosorus parasiticus, Equisetum ramosissimum, Solanum torvum, Salvia plebeia, Corchorus aestuans, Scoparia dulcis, Centella asiatica, Hydrocotyle sibthorpioides, Pilea microphylla, Polygonum aviculare, Eclipta prostrata, Ludwigia octovalvis, Oxalis corymbosa, Ixeris denticulata, Acalypha australis, Capsella bursa-pastoris, Wikstroemia indica, Rorippa indica, Mazus japonicus, Mimoso pudaica, Parthenium hysterophorus, Plantago depressa, Euphorbia hirta, E. thymifolia, Borreria stricta, and Celosia argentea. These weeds usually require relatively stringent habitat. They prefer warm and wet environment, and loose and fertile soil, reproduces mainly by seeds, while two ferns reproduce by spores.

15 slightly harmful weeds belonging to 13 families accounted for 18.52%. They were Typhonium divaricatum, Solanum nigrum, Epimedium indica, Sedum emarginatum, Euphorbia esula, Zehneria indica, Pharbitis nil, Galinsoga parviflora, Cayratia japonica, Hedyotis diffusa, H. auricularia, Cardamine hirsuta, Hypericum japonicum, Pueraria lobata and Emilia sonchifolia.
They were relatively rare in the fields and mainly propagated by seeds in the wild.

Among these weeds, there were 19 invasive alien species belonging to 11 families, 17 species of which were native to the tropics and 12 species were from South America, which were *Alternanthera philoxeroides*, *Conyza canadensis*, *Eleusine indica*, *Cyperus rotundus*, *Crassocephalum crepidioides*, *Abelmoschus moschatus*, *Wedelia trilobata*, *Ageratum conyzoides*, *Amaranthus spinosus*, *Ipomoea cairica*, *Cenchrus echinatus*, *Solanum torvum*, *Scoparia dulcis*, *Pilea microphylla*, *Oxalis corymbosa*, *Mimosa pudica*, *Parthenium hysterophorus*, *Celosia argentea* and *Galinsoga parviflora*.

In addition, among the 19 alien weeds, which of them brought great harm to the crops in the vegetable fields were *Alternanthera philoxeroides*, *Conyza canadensis*, *Crassocephalum crepidioides*, *Eleusine indica*, *Abelmoschus moschatus*, *Wedelia trilobata*, *Ageratum conyzoides*, *Ipomoea cairica*, *Amaranthus spinosus* and *Cyperus rotundus*. The 10 weeds accounted for 52.63% of the total species, which showed that over half of invasive weeds had a great impact on the growth and development of crops. Among them, the harm characteristic of *Alternanthera philoxeroides* is that it can rapidly increase its coverage and form a single superior community in a short period of time by rapid cloning and branching. *Conyza canadensis* is one of the most widely distributed and invasive species. By producing a large number of achenes and spreading with the wind, it spreads very quickly, and can secrete allelochemicals to inhibit the growth of neighboring plants (Wei et al., 2017; Wu et al., 2014), thus causing serious harm. *Wedelia trilobata* and *Ipomoea cairica* are widely distributed. They can release allelochemicals to the soil by means of stem and leaf leaching, residue decay, root exudation, etc., which inhibit the growth of surrounding plants, crowd out or even kill native species, and form a single superior community (Wei et al., 2017; Wu et al., 2014). The biodiversity of the population diffusion area of these weeds is obviously reduced.

**Figure 2.** Percentage of various harm degree weeds in the vegetable fields

### 3. Discussion and Conclusion

The composition of vegetation in the vegetable fields is usually dominated by herbs and subshrubs due to the frequent artificial removal. The species of woody plants are rare and can only stay in the seedling stage. The results showed that there were 81 weeds belonging to 71 genera and 34 families in the vegetable fields in the northern suburb of Meizhou. Among them, Compositae and Gramineae weeds are widely distributed weeds in the world, and they are also the dominant group of weeds in the vegetable fields, which is inextricably related to the resistance, ecological adaptability, growth potential, and fruitfulness of Compositae and Gramineae weeds (Li et al., 2014;
The weeds in the vegetable fields have the typical characteristics of continuous cropping and the dicotyledonous weeds account for the majority of the weed species. The floristic composition of weeds in the vegetable fields was mainly tropical distribution, which shows that the flora of weeds has a strong tropical character, but it has a weaker tropical character than the *Syzygium odoratum* community in Shenzhen Dapeng Peninsula (Zhang et al., 2007) which is also located in the subtropical zone. Moreover, the investigation was conducted only on weeds, and other plants in the area were not investigated and recorded. The floristic composition obtained by statistical analysis could not fully represent the floristic composition of the overall vegetation in this area.

The weeds in the vegetable fields were rich in annual and biennial short-lived weeds, which is consistent with the R-strategy of survival and reproduction of short-lived plants in high-intensity and high-frequency disturbed habitats. Because of their biological characteristics of growth and reproduction, they can be successfully domesticated to establish a population. In the vegetable fields, water and fertilizer conditions are more suitable. Although artificial removal can remove larger individual seedlings and adult plants, but at the same time under the disturbance of continuous tillage, it is beneficial to the germination of weed seeds, so the high intensity and frequency of human interference also increases the proportion of annual plants. Perennials, however, usually have strong ability of asexual reproduction, rotation of vegetable soil and fragmentation of nutrient body will not affect the survival of these weeds, and even contribute to the spread and diffusion of their propagates (Huai et al., 2003; Saito et al., 2010; Scutte, 2014).

The weed community in these vegetable fields was dominated by light-demanding plants and shade tolerant plants. This is due to that light-demanding weeds require sunlight for growth, the vegetable fields usually does not have tall erect woody plant, so it is very suitable for their growth. The tolerance of weeds to light intensity is more extensive, and they can grow well in open space or under the shelter of high crops. While the shade-demanding weeds are fond of shade but not tolerant to strong light irradiation, and they only grow under other higher crops (Sun et al., 2016). In addition, the majority of the weed communities are mesophytes, which are due to those mesophytes have loose requirements for moisture or air humidity than hygrophytes and can be widely distributed in vegetable fields, while hygrophytes need to grow well under humid or high air humidity conditions. Among the 81 weeds in this investigation, 38 species belonging to 21 families caused serious and even very serious harm to crops, most of which were the weeds of Compositae, Gramineae and Amaranaceae. The serous and very serious harmful weeds have no great strict requirement for habitat, so they can be widely distributed and also survive tenaciously in bad environment.

Compared with the weed communities in Hainan Asparagus Orchard (Li et al., 2014) and Qinzhou Pitaya Orchard (Xie et al., 2018) in Guangxi Zhuang Autonomous Region in South China, the common characteristics of the 3 weed communities are the Compositae as the dominant family. *Eleusine indica* also caused great harm to Hainan Asparagus Orchard, Qinzhou Pitaya Orchard and the vegetable fields in the north suburb of Meizhou, which is a gramineous annual plant with developed roots, strong ability of competing for water and fertilizer, rapid reproduction and large amount of seed yield. However, the weeds in the vegetable fields, Hainan Asparagus Orchard and Qinzhou Pitaya Orchard, have great differences between the dominant families and the harm degree of weed species. On the one hand, they may be related to the local specific environment, including soil, water, light, etc. On the other hand, it may be that because of the different planting crops, different growth environment is required, which leads to the difference of human activities in the local area, resulting in the difference of weed species and malignant weed species in different regions (Nagase et al., 2013; Chen et al., 2014). There were 19 alien invasive weeds belonging to 11 families in these vegetable fields. The most common invasive species are the Compositae, such as *Alternanthera philoxeroides*, *Conyza canadensis*, *Eleusine indica*, *Wedelia trilobata*, *Ageratum conyzoides* and *Ipomoea cairica*. Among them, the growth of neighboring plants can be inhibited by allelopathy, such as *Alternanthera philoxeroides*, *Ipomoea cairica*, and *Wedelia trilobata*, which can obviously reduce the biodiversity in the area of population diffusion and cause serious harm to the invading area.
In the vegetable fields, the frequency and amount of application of herbicides, pesticides, domestic sewage and fertilizers could not be small. So these weeds should have strong tolerance and adaptability to these substances. It is essential for these weeds to be uprooted or cleared before fruit or seed ripens to reduce the harm of weeds. The individual number of Compositae and Gramineae are usually the most in the relatively arid regions, but in the area near water, those of Cyperidae and Amaranaceae tend to be more than the two aforementioned families. It is still a technical problem to develop a reasonable physical or chemical method to control weeds in vegetable fields to improve the yield and quality of vegetables.

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