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# Simple and Efficient Cultivation Technology for the Peanut under the Standardization Mode of Single-seed Sowing

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**Abstract** Single-seed sowing is a new, simple and efficient cultivation mode for peanut that realized from cultivation of healthy individual and construction of high-yielding population. The cultivation mode has the obvious advantages in uniform seedling, strong sprouting, seed saving and cost saving, thus it is considered as one of the effective ways for high-yield and high-efficient peanut cultivation in China in the future. Through integrating with other high-efficiency and simple cultivation measures, the single-seed sowing technology system has made conforming to China's national standardization cultivations of peanut and the technology was already applied in the main producing areas of peanut and gained the significant efficiency and abroad application prospects. Based on many years of researches in single-seed sowing technology, high-efficiency fertilization and scientific chemical control in the research team, by combining with the latest research results in plant protection and machinery, this paper described the key points and matters needing attentions from variety selection, planting mode, rational fertilization, planting specifications and field management.

**Key words** Peanut, Single-seed sowing, High efficient cultivation, Technical points

## 1 Introduction

In China, the traditional peanut sowing of 2 seeds per hole not only wastes seeds and needs high cost, but also brings about increasing conflict between individual and group, the group quality declines and the yield becomes not stable<sup>[1]</sup>. With improvement in production conditions and increase in agricultural scientific and technological level, high yield cultivation of crops is developing towards multiple approaches. Establishing high yield group through reducing group and strengthening individuals has been proved an important approach for realizing high yield of peanut under high fertility and water conditions<sup>[2]</sup>. Single peanut plant has high productive potentiality. In high yield condition, changing two seeds per hole to single seed and properly reducing number of groups are favorable for uniform seedling and strong sprouting, and are effective approach for alleviating the conflict between individual and group peanuts and saving cost and reducing consumption of peanuts. For this end, our team made a systematic research on single-seed sowing technology of peanuts since the 1990s<sup>[3-8]</sup> and we established peanut single-seed sowing technology<sup>[9]</sup>. After entering the tenth five-year plan period, at the same time of continuing improving the single-seed sowing technology, through combining the high-efficient fertilization<sup>[10-17]</sup> and scientific chemical control technologies<sup>[1]</sup>, integrating with plant protection and machinery, we developed standardized simple and high efficient sin-

gle-seed sowing technology, and popularized in Huang-Huai-Hai Plain area and southern peanut production areas. The effect of increasing yield and efficiency is significant and application prospect is broad. In this paper, we introduced key points of simple but high-efficient peanut single-seed sowing technology.

## 2 Selecting fine seed in accordance with local conditions

Fine seed is the primary factor for high yield and high efficient cultivation of peanuts. Selection of single-seed sowing varieties should consider following factors: (i) developed root system, high single plant production potentiality and high stability; (ii) the germination rate of seeds above 98%; (iii) suitable ecological and climatic conditions; (iv) strong stress resistance and disease resistance, *i. e.* well resistance to drought, waterlogging, and other natural disasters; (v) no outstanding defects, especially fatal defects; (vi) initial introduction of seed should carry out the introduction test, to ensure the introduced varieties better suit local ecological environment; (vii) regional variety distribution should keep genetic diversity and avoid single variety, to raise the ability of resisting natural disasters; (viii) varieties should be examined and approved by provincial and national competent authorities. On the basis of meeting the above conditions, combining different ecological areas and planting types, the spring cropping area in Huang-Huai-Hai Plain area should select middle mature large peanut varieties, suitably match middle and early mature large and medium-small peanut varieties; wheat interplanting area and summer direct sowing area should select middle and early mature or early mature large peanut varieties, suitably matching pearl bean type peanut varieties; southern peanut production area should select short growth period pearl bean type peanut varieties; north-

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eastern peanut production area should select pearl bean type small peanut and early mature large peanut varieties.

### 3 Applying regional standardized planting methods

In China, peanut production area is large and the distribution is wide. There are certain differences in ecological conditions and planting methods between different production areas. To adapt to demands of mechanical sowing and harvesting, it is required to energetically popularize regional standardized planting methods. Huang-Huai-Hai Plain area mainly adopts three crops two years or two crops one year, has both spring and summer cropping, and planting methods mainly include spring sowing, wheat interplanting, and summer direct sowing. Spring sowing should adopt one big ridge two rows plastic-mulching planting, specifically, 80-85 cm for ridge spacing, 50-55 cm for ridge width, and 4-5 cm for ridge height. Sow two rows of peanuts on the ridge with row spacing 30-35 cm on the ridge; for large peanuts, the hole spacing is 11-12 cm, sow 203000 to 218000 holes per hectare, and actual peanut plants should be not less than 188000; for small peanuts, the hole spacing is 10 – 11 cm, and sow 218000 to 233000 holes per hectare, and actual peanut plants should be not less than 203000. The row spacing for peanuts interplanting with wheat may follow the local planting practice. Generally, it is 30-33 cm for row spacing, 13 – 15 cm for hole spacing, 218000 to 233000 holes per hectare, and actual peanut plants should be not less than 203000. The specifications for summer direct sowing are the same as spring sowing small peanuts.

Southern peanut production area mainly sows spring peanuts, some are autumn and winter peanuts. In order to prevent waterlogging, cage mulching sowing or outdoor cultivation methods are generally adopted, with cage spacing of 120 – 200 cm, cage width of 90-170 cm, cage height of 15 – 20 cm, and number of rows varied with cage spacing, generally 5 – 7 rows, hole spacing varied with row spacing, 218000 to 233000 holes per hectare, and actual peanuts not less than 203000 plants. In northeastern area, one crop per year spring peanut production area may adopt row spacing ridging mulching sowing methods, with ridge spacing of 60-65 cm, hole spacing of 7 – 8 cm, sowing 210000 to 225000 holes per hectare and actual peanuts not less than 195000 plants. Alternatively, large ridge two row mulching method can be adopted.

### 4 Fixing fertilizer with yield, to ensure comprehensive and sustained supply of nutrients

Principle for peanut fertilizer: fertilizer should be fixed in accordance with local conditions, combining organic fertilizer and inorganic fertilizer, mainly N, P, K fertilizer, properly supplemented by Ca fertilizer and trace element fertilizer. According to latest research findings of our team, in soil with medium or above fertility, production of 1 t peanut pods needs 400-500 kg organic fertilizers per hectare, and chemical fertilizer of N15 – 20 kg,  $P_2O_5$  5 – 10 kg, and  $K_2O$  20 – 25kg. 4.5 t peanuts per hectare need application of 1.8 – 2.3 t organic fertilizers, 150 – 300 kg NPK compound fertilizer, 90 – 110 kg slow release urea, 120 – 135 kg

$K_2SO_4$ , or other types of compound or special fertilizers with equivalent content. For yield above 4500 kg, increase fertilizers as per 1 t peanut pods per hectare. Besides, in accordance with local conditions of soil nutrients, Ca fertilizer and trace element fertilizers should be applied once every two years. For acid soil, physiologically alkaline fertilizers such as lime should be used; for alkaline soil, physiologically acid fertilizers such as gypsum should be applied. Besides, it is appropriate to select some functional fertilizers in accordance with local practical production conditions. For example, for continuous cropping soil, lime nitrogen fertilizer can be increased in winter ploughing, which can significantly reduce number of diseases and worms in soil; before sowing, application of biological bacterial manure can balance microbial population and increase the soil fertility.

For peanut pure cropping area (including spring sowing and summer direct sowing), take organic fertilizer, NPK fertilizers and trace element fertilizers as base manure, and uniformly apply fertilizers to 0-30 cm arable layer before sowing for Ca fertilizer pure cropping area; furrow application of fertilizer in 5-10 cm soil layer beside peanut plants before or after blooming of peanuts for interplanting area.

### 5 Checking on the quality of sowing, to ensure whole sprouting in one time of sowing

Whole sprouting is the basis of high yield of single-seed precision sowing. For this end, following works should be done.

**5.1 Proper seed treatment** Before peeling peanuts, dry them in the sun for 2-3 days; peel off in 10-15 days before sowing. After peeling, divide seeds into 1, 2, and 3 grades, large and plump ones as grade 1, weight less than 2/3 of grade 1 as grade 3, and weight between grade 1 and grade 3 as grade 2. Then, use grade 1 and grade 2 seeds for sowing. Before sowing, use 30% Chloropyrifos 3750 ml + 2.5% Imidacloprid 750 ml + Celest 300 ml (three-in-one seed dressing) for one hectare seeds (225-255 kg), to prevent root rot, aphids, and underground pests, *etc.*

**5.2 Sowing in proper period and with adequate soil moisture** For peanut sowing, temperature should be considered. For spring large peanuts, the daily average temperature at 5 cm above ground should be stably higher than 15°C, and higher than 12°C for small peanuts. Besides, it is required to adjust the sowing period to make environmental conditions for peanut growth consistent with local climatic conditions, to maximally use local natural resources, and avoid the period when natural disasters frequently occur. Different provinces have great differences in suitable sowing period, and most provinces are suitable in March to May. Peanuts interplanting with wheat are generally sowed in 15-20 days before wheat harvesting. For summer direct sowing, clean stubbles of previous crops before sowing, and the interval should be controlled within 3-4 days. The relative soil moisture should be 70-75%. In other words, held by hand, soil of arable layer can become crumbs, and it feels loose when rubbing with hands.

**5.3 Mechanical sowing** The single-seed precision sowing is

not suitable for manual sowing because the hole spacing is small. Generally, mechanical sowing is adopted. For spring sowing peanuts, one or two times of rotary tillage should be carried by rotary tiller, to reach level land, fine soil, and uniform fertilizer. It is required to adopt single-seed fine combined sowing machine with excellent agronomic performance, to complete ridging, sowing, soil covering, suppression, spraying of herbicide, mulching, and soil pressing in one time. For peanuts interplanting with wheat, self-propelled single-seed interplanting sowing machine is applied. For summer direct seeding, after harvest of previous crops, sow peanuts in accordance with sequence of stubble cleaning, fertilizer application, tillage, rotary tillage, and mechanized sowing. No matter which sowing methods, hole spacing should be uniform and depth should be consistent (3-5 cm). For land parcels covered with plastic film, the soil coverage thickness above sowing row should be 3-4 cm, to ensure peanuts are able to break film and sprout. For herbicide, it is recommended to use S-metolachlor herbicide 1350-1500 ml per hectare, or Acetochlor 1800-2250 ml, mixed with 600-750 kg water. In addition, three ditches of peanut fields should be unblocked, not subject to waterlogging.

## 6 Taking key points of field management and building high quality group structure

### 6.1 Early stage management

**6.1.1** Promptly release seedlings, reseed and clean up unnecessary branches; for mulching peanuts, when seedlings break the soil and green leaves emerge, remove soil pile above the sowing row to ridge furrow, to expose the peanut cotyledons. If peanut seedlings fail to break film and sprout on their own, manually break the film to release the seedlings. After seedlings become uniform, promptly check seedlings, and vernalize and reseed for lack of seedlings for consecutive two holes. From the seedling stage (four compound leaves in main stalk), it is required to promptly check and dig out side branches of peanuts buried under film, to realize strong and healthy growth, conduct two to three times before starting flowering.

**6.1.2** Promptly watering and intertillage: peanuts interplanting with wheat grow with wheat before sprouting, consume high water from soil. Once peanut seedlings appear withered at noon, promptly water along ditches. Generally, one to three times of watering is needed before wheat harvesting, to ensure smooth sprouting. After wheat harvesting, promptly clean up stubbles and remove weeds, conduct topdressing for parcels requiring fertilizer, open ditches in one side of peanut plants, and conduct intertillage when the soil moisture is appropriate, to reduce restoration period of seedlings. For outdoor peanuts, after sowing and soil covering, spray Acetochlor on soil surface, to prevent weeds. For land parcels with three-in-one seed dressing, prevention of diseases and pests is generally not needed at seedling stage. Spring and summer peanuts sowed with adequate soil moisture do not need watering. Moderate aridity is favorable for development of root system, raising the ability of plants resisting drought and waterlogging, and

promoting bud differentiation.

### 6.2 Middle stage management

**6.2.1** Organic combination of prevention of diseases and chemical control to reduce times of field work; we combined "ahead of time" and "by times" peanut slow control early aging prevention technologies developed by our team<sup>[1]</sup> with plant disease and insect pest technology, and optimized the simplified management method with functions of preventing plant diseases and insect pests, and reducing field management works by more than a half. When the diseased leaf rate of peanuts reaches 10%, spray leaves using 900-1200 g 60% Baitai Water Dispersible Granules per hectare diluted with 375-450 kg water; when main stalks of peanuts grow to 25 cm (general field) or 30 cm (high yield field) high, it is recommended to use 600-750 g 2250-3000 ml bactericide 12.5% Diniconazole wettable powders + bactericide 6% tebuconazole microemulsion to prevent leaf diseases for per hectare, add 525-600 kg water, generally spray two times with interval of 7 to 10 days. If main stalks grow to 35 cm (general field) or 40 cm (high yield field), spray one time of plant growth inhibitor 5% uniconazole + 60% Baitai Water Dispersible Granules at 900-1200 g/hectare. During this period, if there appears *Helicoverpa armigera* Hubner, add 1500-1800 ml 50% Methyl parathion or similar insecticide to realize multiple prevention by one time of spraying. For peanut height lower than 25 cm in the whole peanut life, chemical control is not necessary, disease prevention may adopt bactericide without growth inhibition like Baitai, and add proper dosage of foliar fertilizer like Boron-molybdenum-Nitrogen to promote plant development.

For underground pests such as *Holotrichia oblitera* and *Elaterridae*, generally "three-in-one" seed dressing can effectively control such pests if the situation is not serious. If the situation is serious, before June when soil is moist before or after rain, mix 15% Chlorpyrifos with soil at 3000-3750 g/hectare, and apply the agent to the plant base in a centralized and uniform way.

**6.2.2** Properly watering: the middle stage of growth (pegging stage and pod bearing stage) is the period when peanuts are most sensitive to water and also the period when peanuts need water most. Therefore, drought at this stage will greatly reduce peanut yield and accordingly it is a key period of water management. When peanut leaves become withered at noon, promptly water to ensure normal growth, flowering and bearing fruit.

**6.2.3** Intertillage and earthing up: for outdoor peanuts, when field plants grow to ridge closing time, dig ditches to earth up soil using animal power or mechanical plough when soil moisture is appropriate. Earthing up should realize clean ditch, soft soil, fat ridge waist, and concave ridge top, to realize more pegs penetrating into soil to bear fruit.

### 6.3 Later stage management

**6.3.1** Topdressing for preventing early aging: at the later stage of peanut growth, the absorption ability of root system gradually declines, which easily leads to ground parts unable to make ends meet and leads to early aging and reducing the yield. Therefore,

foliar topdressing may be carried one month ahead of peanut harvesting. Spray 1800-2250 g  $\text{KH}_2\text{PO}_4$  + 5250-6000 g urea + 1050-1200 g 75% chlorothalonil wettable powder, diluted with 525-600 kg water, for 2 times with interval of 10-15 days for one hectare peanuts. Extend functional period of upper leaves to increase the fruit rate.

**6.3.2 Promptly draining and irrigating to increase yield rate:** if drought occurs at later stage of growth, promptly water the field to provide proper soil moisture at the same time of prevent early aging of peanuts and aspergillus flavus contaminating peanut pods, especially in land parcels of mechanical harvesting, soil moisture exerts great influence on harvesting quality. At this stage, do not excessively water the field, to avoid rotten peanuts or delay of harvesting due to rain after watering. If waterlogging occurs at this stage, promptly drain accumulated water in the field.

**6.3.3 Harvesting at proper time and gradually increasing proportion of mechanical harvesting:** when only 3 to 4 green leaves are left in main stalks and more than 70% pods become hardened, cob-webbing is clear, and inner wall of peanut shell takes on greenish brown patch, it is necessary to harvest peanuts. We advocate mechanical harvesting, including segmented harvesting and combined harvesting. Segmented harvesting is carried out by digging and picking. At present, digging machine can complete peanut digging, soil shaking and laying processes. Later, wet picking or field drying in the sun, and manually collect, finally deliver to courtyard or open space for picking. At present, China's digging machine and picking machine are relatively mature, and operation quality is relatively stable, but stage operation consumes time and labor. Combined harvesting machine can complete digging, soil shaking and picking just in one time, and the machine is basically mature, the field operation efficiency is high. However, the harvesting quality is subject to soil nature and soil moisture, and it may be popularized in suitable areas.

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