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The effect of sowing dates, methods and seeding rates on the growth, development and yield of sesame (Sesamum indicum L.)

Ekish muddatlari, usullari va urug‘ sarflash me’yorlarining kunjut (Sesamum indicum L.) o‘sishi, rivojlanishi va hosildorligiga ta’siri

Влияние сроков, способов посева и норм высева на рост, развитие и урожайность кунжута (Sesamum indicum L.)

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ENGLISH

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Abstract. Sesame (Sesamum indicum L.) is an important oilseed crop cultivated in tropical, subtropical and warm temperate regions. Its productivity is strongly influenced by the conditions under which the crop is established and by the spatial arrangement of plants in the field. This article examines the effects of sowing dates, sowing methods and seeding rates on sesame emergence, vegetative growth, reproductive development and seed yield. The review shows that the optimum sowing period depends on soil temperature, moisture availability, rainfall distribution, cultivar maturity and the environmental conditions prevailing during flowering and seed filling. Sowing too early into cool or dry soil may result in slow and uneven emergence, while delayed sowing can shorten the period available for branching, capsule formation and seed filling. Line sowing and precision drilling generally improve seed placement and facilitate inter-row cultivation, whereas broadcasting may lead to uneven plant distribution. Seed rate determines the initial plant population, but the final stand also depends on seed quality, germination, placement depth and field conditions. Excessive density can intensify competition and reduce branching per plant, while insufficient density may leave unproductive gaps. The article concludes that sowing date, method, row spacing and seed rate should be selected as an integrated system and validated under local agro-climatic conditions. The paper is a review of published evidence and does not report new experimental results.

Keywords: Sesame, Sesamum indicum L., sowing date, sowing method, seed rate, plant population, crop growth, development, seed yield, agronomic practices

O‘ZBEKCHA

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Annotatsiya. Kunjut (Sesamum indicum L.) tropik, subtropik va iliq mo‘tadil mintaqalarda yetishtiriladigan muhim moyli ekindir. Uning mahsuldorligi ekinning qanday sharoitda unib chiqib shakllanishiga va dalada o‘simliklarning fazoviy joylashuviga kuchli bog‘liq. Maqolada ekish muddatlari, ekish usullari va urug‘ sarflash me’yorlarining kunjutning unib chiqishi, vegetativ o‘sishi, generativ rivojlanishi va urug‘ hosiliga ta’siri ko‘rib chiqiladi. Sharh shuni ko‘rsatadiki, maqbul ekish muddati tuproq harorati, namlik bilan ta’minlanganlik, yog‘inlarning taqsimlanishi, navning pishish muddati hamda gullash va urug‘ to‘lishi davridagi muhit sharoitlariga bog‘liq.

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Sovuq yoki quruq tuproqqa juda erta ekish sekin va notekis unib chiqishga olib kelishi mumkin, kechiktirib ekish esa shoxlanish, ko‘sakcha hosil bo‘lishi va urug‘ to‘lishi uchun mavjud davrni qisqartiradi. Qatorlab va aniq ekish odatda urug‘ning joylashuvini yaxshilaydi va qator oralariga ishlov berishni osonlashtiradi, sochma ekish esa o‘simliklarning notekis taqsimlanishiga olib kelishi mumkin. Urug‘ sarflash me’yori dastlabki o‘simliklar sonini belgilaydi, biroq yakuniy ko‘chat qalinligi urug‘ sifati, unuvchanligi, ekish chuqurligi va dala sharoitlariga ham bog‘liq. Haddan tashqari qalinlik raqobatni kuchaytirib, bir o‘simlikdagi shoxlar sonini kamaytiradi, yetarli bo‘lmagan qalinlik esa hosilsiz bo‘shliqlar qoldiradi. Ekish muddati, usuli, qator oralig‘i va urug‘ sarflash me’yorini yagona tizim sifatida tanlash hamda mahalliy agroiqlim sharoitida sinab ko‘rish zarur degan xulosaga kelinadi. Maqola nashr etilgan ma’lumotlar sharhi bo‘lib, yangi tajriba natijalarini o‘z ichiga olmaydi.

Kalit so‘zlar: kunjut, Sesamum indicum L., ekish muddati, ekish usuli, urug‘ sarflash me’yori, o‘simliklar qalinligi, o‘simlik o‘sishi, rivojlanish, urug‘ hosildorligi, agrotexnik tadbirlar

РУССКИЙ

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Аннотация. Кунжут (Sesamum indicum L.) — важная масличная культура, возделываемая в тропических, субтропических и тёплых умеренных регионах. Его продуктивность в значительной мере зависит от условий формирования посевов и пространственного размещения растений в поле. В статье рассматривается влияние сроков посева, способов посева и норм высева на всхожесть, вегетативный рост, генеративное развитие и урожайность семян кунжута. Обзор показывает, что оптимальный срок посева зависит от температуры почвы, влагообеспеченности, распределения осадков, скороспелости сорта и условий среды в периоды цветения и налива семян. Слишком ранний посев в холодную или сухую почву может приводить к медленным и неравномерным всходам, а запоздалый посев сокращает период, необходимый для ветвления, формирования коробочек и налива семян. Рядовой и точный посев, как правило, улучшают размещение семян и облегчают междурядную обработку, тогда как разбросной посев может приводить к неравномерному распределению растений. Норма высева определяет исходную густоту растений, однако итоговая густота стояния зависит также от качества семян, всхожести, глубины заделки и полевых условий. Чрезмерная густота усиливает конкуренцию и снижает ветвление растений, а недостаточная может оставлять непродуктивные пропуски. Сделан вывод, что срок посева, способ, ширину междурядий и норму высева следует выбирать как единую систему и проверять в местных агроклиматических условиях. Статья является обзором опубликованных данных и не содержит новых экспериментальных результатов.

Ключевые слова: кунжут, Sesamum indicum L., срок посева, способ посева, норма высева, густота растений, рост культуры, развитие, урожайность семян, агротехнические приёмы

1. INTRODUCTION

Sesame (Sesamum indicum L.) is one of the oldest cultivated oilseed crops and remains an important source of edible oil, protein-rich meal and food ingredients. The crop is grown in a wide range of production systems, from smallholder rain-fed farms to more intensive commercial fields. Sesame is valued for its relatively good adaptation to warm and dry environments; however, its ability to withstand periods of limited rainfall does not mean that it is unaffected by water stress. Adequate moisture is essential for germination and early establishment, and environmental conditions during flowering and capsule development strongly influence final productivity.

Sowing date, sowing method and seed rate are closely related management decisions. Sowing date determines the temperature and moisture conditions experienced during germination and the timing of later growth stages. Sowing method affects seed distribution, planting depth, row arrangement and the possibility of mechanical or manual inter-row cultivation. Seed rate influences the number of plants established per unit area and the level of competition among them. The optimum value of one factor may change according to the others: a precision seed drill, for example, can establish a more uniform stand with less seed than an imprecise broadcasting system.

The objective of this article is to review and explain how sowing dates, sowing methods and seeding rates affect the growth, development and yield of sesame. Particular attention is given to the biological processes through which planting decisions influence plant population, branching, flowering, capsule formation and seed filling. The review also identifies practical principles for developing locally appropriate recommendations.

2. MAIN PART

2.1. Biological characteristics of sesame related to crop establishment

Sesame is a warm-season annual plant. Germination and early seedling development are favoured by warm soil and adequate moisture. Because the seed is small, the seedling must reach the soil surface before its limited food reserves are exhausted. A fine, level and well-prepared seedbed, shallow seed placement and good seed–soil contact are therefore essential. Production guidance from the Indian Institute of Oilseeds Research recommends shallow sowing and notes that sesame is sensitive to waterlogging [3]. The recommended depth in that guide is approximately 2.5 cm, although the appropriate depth in practice depends on soil texture, moisture and the planting equipment used.

Following emergence, sesame develops a main stem and, depending on the cultivar and growing environment, lateral

branches. Flowers are produced along the stem and branches. After successful pollination and fertilisation, capsules develop and contain the seeds that determine the harvested yield. Important yield components include the number of productive plants per unit area, branches per plant, capsules per plant, seeds per capsule and individual seed weight. Each of these components may respond to planting date and plant density.

Sesame has a degree of morphological plasticity. When plants have more space, they may produce additional branches and capsules. Under dense conditions, plants often compete more strongly for light, water and nutrients; they may grow taller while producing fewer branches per plant. However, the largest individual plant is not necessarily the most productive crop per hectare. A field with fewer plants may have highly branched individuals but still produce less seed per unit area. The agronomic goal is to balance the productivity of each plant with the number of plants occupying the field.

2.2. Influence of sowing dates on growth and development

Sowing date determines the environmental conditions under which sesame passes through germination, seedling establishment, branching, flowering and seed filling. If sowing takes place before soil temperature and moisture are suitable, emergence may be slow and uneven. If planting is delayed, the crop may encounter high temperatures, declining soil moisture or an unfavourable day-length pattern during reproductive development. Depending on the region, late sowing can shorten the vegetative and reproductive periods and reduce the time available for capsule development and seed filling.

A review of sesame sowing-date studies reports that yield often decreases when sowing is delayed beyond the locally optimum period, although the best planting window differs among cultivars and agro-ecological zones [5]. In the Faisalabad field experiment, four July sowing dates were compared. Crops sown on 8 and 15 July produced the highest seed yields in that study, associated with favourable capsule number per plant and seeds per capsule. Yield increased as row spacing widened from 30 to 45 cm, but declined at 60 cm [1]. The findings apply to the cultivar and environmental conditions tested in Faisalabad.

Consequently, the practical aim is not to sow as early as possible under all circumstances. Sowing should be carried out when the seedbed is warm and moist enough to support rapid emergence and when the selected cultivar has sufficient time to complete flowering and seed filling before the end of the growing season. Multi-year local trials are needed to identify the most reliable sowing window, particularly in areas where rainfall onset and spring temperatures vary considerably.

2.3. Influence of sowing methods and row spacing

Broadcasting, line sowing or drilling, and dibbling are commonly used methods of establishing sesame. Broadcasting distributes seed over the soil surface, after which it is covered by shallow tillage or another operation. This method is simple and may be used where specialised equipment is unavailable. However, it can result in uneven seed distribution and variable planting depth. Dense patches may occur next to areas with few or no plants, making thinning, weed control and harvesting more difficult.

Line sowing places seed in rows at a planned spacing. It generally provides more systematic plant distribution and makes inter-row cultivation, mechanical weeding and fertiliser placement easier. The Indian Institute of Oilseeds Research identifies line sowing as useful for intercultural operations and indicates that seed drills can reduce the seed quantity required compared with broadcasting [3]. The drill must nevertheless be adjusted carefully because small sesame seeds require accurate metering and shallow, consistent placement. Incorrect equipment settings can bury seed too deeply or create an irregular stand.

Row spacing affects canopy closure, branching and competition. Narrow rows may cover the soil more rapidly and suppress weeds through shading, but they can intensify competition and restrict access for inter-row cultivation. Wider rows provide more room for branching and field operations, but excessively wide rows may leave soil unoccupied and reduce the number of plants per hectare. The Faisalabad experiment found 45 cm to be more favourable than 30 cm or 60 cm under its tested conditions [1]. Other production systems may require different spacings according to cultivar architecture, rainfall, machinery and target plant population.

2.4. Influence of seed rate and plant population

Seed rate is the quantity of seed sown per unit area, usually expressed in kilograms per hectare. It should not be confused with the final plant population. The number of established plants depends on seed germination, seed health, sowing depth, soil moisture, crusting, pests, diseases and seedling mortality. A recommendation for seed rate must therefore be considered together with seed quality, equipment accuracy and the desired stand.

A seed rate that is too low may result in gaps, uneven maturity and reduced yield per hectare. Plants next to gaps may compensate by producing additional branches, but this response is not always sufficient to replace the missing plants. An excessively high seed rate may cause overcrowding and competition for light, water and nutrients. Plants may become elongated and weak, branch less and, in some conditions, become more susceptible to lodging. Dense stands can also make crop operations more difficult.

In the Nigerian factorial study, seed rates of 2.5, 5.0, 7.5 and 10.0 kg/ha were compared. The lowest seed rate produced more seeds per plant in some observations, while the 5.0 kg/ha treatment gave a higher yield per hectare under the tested conditions. The authors recommended drilling at 5.0 kg/ha for their study environments [7]. This finding illustrates the difference between individual-plant performance and area-based yield. A plant at low density may produce more branches or seeds, but the crop may still yield less if too few plants occupy the field.

Seed rate should be selected by considering thousand-seed weight, germination percentage, expected field emergence, row spacing and the target plant population. Precision sowing can reduce seed wastage and improve uniformity. Where broadcasting is used, a different rate may be required because seed placement is less precise; however, increasing the rate without considering competition can create an excessively dense crop.

2.5. Combined effects on yield formation

Sowing date, sowing method, row spacing and seed rate influence sesame yield through connected processes. The sowing date determines the duration and environmental quality of the growing period. The method and spacing determine how plants are distributed in the field. Seed rate contributes to the number of plants that can establish. A favourable sowing date cannot fully compensate for a poor plant stand, and accurate seed placement cannot overcome severe drought, waterlogging or unsuitable temperatures.

Final seed yield can be understood through several major components: the number of productive plants per unit area, capsules per plant, seeds per capsule and average seed weight. Delayed sowing may reduce the time available for branching and capsule formation. High plant density may increase the number of plants per hectare but reduce branches and capsules per plant. Wider spacing may encourage branching but reduce plant number. The final yield is the combined outcome of these components rather than any single characteristic.

For Uzbekistan and other continental environments, local field trials should compare several sowing windows, locally adapted cultivars, row spacings and seed rates. Measurements should

include emergence percentage, plant density, plant height, branch number, days to flowering, capsule number, seeds per capsule, thousand-seed weight, seed yield and, where relevant, oil content. Replication across seasons is particularly important because rainfall and temperature can vary substantially from year to year.

3. CONCLUSION

Sowing dates, sowing methods and seed rates are important determinants of sesame establishment, growth, development and seed yield. The optimum sowing period depends on soil temperature, moisture availability, rainfall distribution, cultivar maturity and the environmental conditions expected during flowering and seed filling. Evidence from different production regions indicates that both excessively early and delayed sowing can reduce performance when the crop encounters unfavourable conditions. The magnitude of the response differs among cultivars and environments.

Line sowing and precision drilling generally offer advantages in seed distribution, plant arrangement and inter-row weed management. Broadcasting may remain useful where equipment is unavailable, while dibbling can provide defined plant placement in labour-based systems. The best method is the one that produces a uniform stand and permits efficient crop management under local conditions. Row spacing should balance plant population, branching and canopy development.

Seed rate must be selected according to seed quality, sowing method, row spacing, equipment accuracy and the target plant population. A low rate can leave gaps, whereas an excessive rate can increase competition and weaken the crop. The substantial differences among published recommendations confirm that seed rates are region-specific and should not be transferred without local validation.

In conclusion, high and stable sesame productivity is most likely when sowing date, sowing method, row spacing and seed rate are planned as one integrated agronomic system. Further replicated field experiments under Uzbekistan's agro-climatic conditions are needed to develop cultivar-specific recommendations and evaluate the interaction of these factors across contrasting seasons.

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Author contributions *CRediT*

Conceptualization; Methodology; Investigation; Data curation; Writing – original draft; Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

Generative AI disclosure

Not used.

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