AgriCos e-Newsletter
ISSN: 2582-7049
Volume: 02 Issue: 04 April 2021 Article No: 01

Seed Setting and Grain Filling in Sunflower

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SUMMARY

Seed setting and grain filling problems are two most important constraints in sunflower production and often considered to be the major reasons for low productivity. Besides poor agronomic management, there are several genetic, physiological and environmental factors which cause poor seed setting and filling in this crop. The sporophytic type of self-incompatibility mechanism is one of the genetic reasons for poor seed setting. One of the means to alleviate this problem is to identify the self-fertile lines and thus increase seed set and productivity. The physiological mechanisms that regulate seed setting and grain filling in sunflower are complex.

INTRODUCTION

Sunflower is the third most important oilseed crop in the Middle East after soybean and palm oil and has diverse markets for both oilseed and non-oilseed use including both as a bird food and as human snack food (Charney, 2010). High temperature at flowering and seed formation stage leads to pollen death and decreased seed fertility, and empty seed can form a high percentage at maturity exceeding 50% in some cultivars (Dag *et al*., 2002). The major production constraints in sunflower are poor grain filling and seed setting, lack of uniformity in open pollinated varieties leading to production instability, excessive vegetative growth and lack of photosynthetic activity at the time of seed filling and improper translocation of photosynthates. To improve the productivity, translocation of photosynthates from vegetative organs to seed is very important.

Seed Setting Constraints or Causes behind Poor Grain Filling

In sunflower more ill filled grains are formed due to poor seed setting since this is highly a cross pollinated crop. The main reasons for poor seed setting are as follows:

- Use of impure seed
- Less population of honey bees impairs cross pollination
- Due to heavy rains at flowering stage and high humidity pollen grains are washed off
- Because of high temperatures prevailed at the time of pollination the pollen grains will be dried up
- Lack of sufficient soil moisture at seed setting
- Deficiency of phosphorus and micro nutrients
- Excess nitrogen application
- Due to insect, disease and bird damage
- Seed setting starts from periphery to the centre of flower, which normally completes within a span of 10 days. As seed setting progresses, the non-availability of both macro and micro nutrients in required proportions is one of the reasons for poor seed setting.

Steps to be Taken Up For Proper Seed Setting

The following steps should be taken up for proper seed setting in sunflower:

- Decide optimum seeding period in such a way that the flowering should not coincide with extremes of temperature, heavy rainfall and fog.
- Use only pure and quality seeds of high yielding varieties or hybrids.
- Follow only recommended fertilizer schedule.
- Avoid excess use of nitrogen provided that there is no phosphorus deficiency.
- At the crop age of 30 days there should not be any deficiency of N.
- Rectify the deficiency of micro nutrients if observed.
- If sunflower is grown as rainfed *Rabi* crop in heavy soils, grow nearby fields of safflower or safflower as intercrop so that the activity of honey bees can be increased.
- Honey bees are attracted by yellow flowers and the honey dew available in flowers of Niger. Hence, grow Niger around the fields of sunflower so that fertilization can be improved.

- Establish more plant population per unit area, otherwise large sized flowers are produced and cause poor seed setting in centre of the flower.
- Grow the crop if possible east to west to avoid shading of one row on the other.
- Keep 2-3 honey bee colonies to activate honey bee activity and to increase crop pollination which also gives additional income from honey.
- See that there should not be any moisture stress from bud formation to flowering and milking of seed stages.
- From flowering on wards necessary plant protection measures are to be taken and also bird scaring.
- During flowering period spray insecticides mostly during evening.
- Spray Cycocel @ 50 ppm at 40 and 60 days age of crop to increase yield through better seed setting.
- Rub the flowers of opposite lines at flowering period between 8-11 AM and 3-5 PM to obtain more cross pollination.
- Rub the flower with smooth cloth or cotton at flowering time between 8-11 am on every day or on alternate days for 10-15 days to increase cross pollination.
- This operation gives 25% higher yield.
- At the time of rubbing if tobacco caterpillar or gram caterpillar are observed on flowers, better pick them and destroy to reduce the crop damage.

Major Factors Causing Seed Setting and Grain Filling Problem

Following are the major factors which cause seed setting and filling problem in sunflower:

Genetic factors and their management

Low autogamy

- Evaluation of hybrids and their parental lines for their autogamy becomes necessary before releasing any genotype or hybrid.
- Hybrids can produce significantly more autogamous seeds over better parent.
- One should grow hybrids for commercial cultivation of sunflower.

Self-incompatibility

- Self-incompatibility is the inability of fully functional pollen grains to fertilize and seed set on self-pollination.
- Self-incompatibility of sporophytic nature is reported in sunflower that is major cause for poor seed setting.
- Identification of self-fertile lines is one of the major means for the purpose of improvement of seed setting and higher productivity.
- Hybrids are generally more vigorous, uniform, self-fertile and resistant to many pests and diseases.
- Hybrids/genotypes should be tested for their combining ability prior to growing for commercial purpose.

Physiological Factors and Their Management

Vascularisation

- Several possible physiological reasons may be responsible for empty achenes in capitulum of sunflower.
- Peripheral seeds are more developmentally mature than intermediary and central seeds due to the poor vascularisation of central flower head.
- There are no vascular bundles present in the centre of the flower head.
- Therefore, intermediary and centrally located seeds must receive solutes indirectly by horizontal transport from peripherally located vascular bundles.
- Centrally located seeds are able to catch up with peripheral seeds during mid-flowering stage.
- Foliar spray of Gibberellic acid (GA) and Benzyl adenine (BA) is advisable for enhancing vascular connections between the outer and inner parts of the capitulum and to increase grain yield by reductions in the percentage of empty achenes in inner portion of capitulum of sunflower.
- BA @ 150 mg/l + GA @ 150 mg/l should be applied at 40 days after emergence to significantly reduce the percentage of empty achenes and increase achene weight.

High photorespiration

- As sunflower is C_3 plant there is a degree of wastage of photo assimilates due to photorespiration which can otherwise be utilized for building yields.

Effect of source-sink ratio

- Improper development of seeds is caused due to inadequate supply of assimilates or owing to source limitation.
- Source–sink ratio is defined as leaf area per floret (LAF) which can be altered by invasive factors such as removal of florets, defoliation etc. and non-invasive factors like pulse of chilling, short day conditions, shading during leaf or floret initiation etc.
- An increase or decrease in LAF can improve or impair both seed set and filling.
- The influence of source–sink ratio on seed setting is always greatest in the centre, while peripheral whorls are not usually affected.
- Achene mass was affected in all parts of the capitulum.
- Source limitation is considered as a significant reason behind formation of empty achenes grown under non-stressed situations.

Environmental factors and their management

Moisture stress

- Productivity of sunflower is often affected by various environmental stresses, of which moisture stress is the most important one.
- Maximum decline in LAI and dry matter accumulation in sunflower is observed when the crop is subjected to moisture stress at flowering stage resulting reduction in yield.

Intercepted solar radiation

- A reduction in intercepted Photosynthetically active radiation (PAR) during a short period of seed filling can affect weight per seed in sunflower.

Agronomic Management

Pre sowing treatments

- Seed invigoration treatment helps to improve the germination and vigour of the seed and ultimately it establishes a good field stand and higher yield.
- *Trichoderma harzianum* is an antagonistic agent which suppresses the growth of many fungi found on seed and in soil.
- Protection given by *Trichoderma harzianum* may help in germination of poor vigour sunflower seeds and subsequently increase the yield.
- Seed treatments with KCl (0.5%), $MnSO_4$ (0.5%), GA_3 (50 ppm), Thiram are also effective in increasing seed yield of sunflower.

Planting time and planting design

- Among several crop production practices, planting date decides the correct expression of a genotype for all morphological characters and physiological processes.
- A significant increase in seed yield can be observed due to early planting in July or December for *kharif* or spring seasons over late planting in August or January respectively.
- The enhancement in seed yield was due to improved germination percentage and seedling vigour, which subsequently increase the yield components and yield.
- Sunflower sown in December comes to flowering between March-April and since during these months honeybee activity is maximum, it helps in better pollination and good seed setting.

Crop geometry

- Suitable crop geometry and phosphorus application besides other agronomic practices are of paramount importance as sunflower has higher phosphorus requirement.

- Crop geometry of 60 cm x 20 cm can record significantly higher values of growth and yield attributes.
- Phosphorus application increases filled seed/head, seed weight/head and seed yield.

Fertilization

- Sunflower is often considered as a soil depleting crop, which puts heavy demands on soil and applied nutrients.
- Owing to the higher nutrient uptake, the crop is very much responsive to the applied nutrients.
- Among the different nutrients required by sunflower, Nitrogen and Phosphorus are the primary limiting nutrients under most environments.
- Boron plays a major role in membrane integrity and cell wall development and it helps in pollen tube growth.
- Boron also plays an important role in translocation of sugars; hence, application of boron is beneficial in sunflower.
- Sulphur plays a vital role in formation of chlorophyll, amino acids *viz.* cystine, cysteine and methionine.
- Sulphur increases seed yield due to more accumulation and translocation of amino acids and amide substances to the reproductive organs.

Staggered sowing

- The problem of non-synchrony is generally observed in sunflower hybrids.
- The male parent flowers later than seed parent.
- To avoid this problem sowing male parent early to female parent was suggested.

Irrigation

- Water and fertilizer are two most important inputs in agronomic aspects of crop management.
- Judicious application of irrigation and nitrogen is essential to achieve higher benefits, especially under limited resource conditions.

CONCLUSION

Sunflower is a common oilseed crop cultivated in India with wider utility which is used as a source of edible oil, and as raw material for agri-based industry. The photo assimilates supply in the capitulum largely depends on the phyllotaxy of source leaves and the position of sinks in developing inflorescences. Higher proportions of empty achenes up to 60%, especially in the centre of capitulum are resulted from source limitation. During seed filling, maximum import of photo assimilates appear in the intermediate whorls, while central whorls always exhibit the lowest import leading to poor grain filling. Potential yield of sunflower is highly dependent on environmental conditions during life cycle of the crop. Therefore, breeding for fertile lines, plant physiological manipulations, environmental control and good agronomic management can alleviate the problem of seed setting and grain filling in sunflower to some extent.

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