EFFECT OF SPLIT APPLICATION OF NITROGEN AND INTERACTION EFFECT OF NITROGEN AND PLANT POPULATION ON GROWTH AND YIELD OF SUNFLOWER (HELIANTHUS ANNUUS L.) - A REVIEW

M. Vijaya Kumar, P. Subbian, A.C. Lourduraj, R. Selvaraju and S. Ramesh
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 641 003, India

ABSTRACT

Sunflower is an important oilseed crop which ranks third in the world next to soybean and groundnut in the edible oil production. The productivity of sunflower can be increased with judicious use of inputs under higher plant population levels. Split application of N has been reported to favourably influence the nutrient uptake, growth, yield characters and seed yield of sunflower. In general, crop growth and dry matter accumulation of sunflower are higher at increased N and population levels. Reports of higher sunflower yield at higher plant population and N levels have been widely reported.

Sunflower with its photo-insensitivity and adaptability to wider range of environment has greater potential in increasing the total oil seeds production in India. Besides its oil quality, sunflower seed has 30 per cent protein, which is more useful as good livestock feed. Under dryland situation, maintenance of plant population plays a major role in increasing the sunflower yield especially in high rainfall years. The productivity of sunflower can also be increased with judicious use of inputs under higher plant population levels. It is also important to reduce the yield loss against abiotic stress especially with inadequate soil moisture by proper manipulation of plant population. Under low rainfall situations, maintaining lesser plant population than the recommended level would be beneficial for better yields. Among the plant nutrients, nitrogen plays an important role in deciding growth and yield of sunflower. Nitrogen is the most common element influencing the sunflower yield (Ashnour et al., 1985 and Halder et al., 1998). As moisture is the most limiting factor in drylands, split application of N provides the opportunity to make seasonal decision to optimise the N dose based on rainfall occurrence. This indicates that fertilizer requirements and time of application may not be same under highly variable rainfall situations. It is necessary to optimise the time of split application of nitrogen with respect to production level for a particular rainfall pattern. The research results on the effect of split application of nitrogen and the interaction effect of nitrogen and plant population on the growth and yield of sunflower are reviewed in this paper.

Effect of split application of nitrogen on growth components

Aydin (1996) reported increased plant height due to application of nitrogen at different growth stages of sunflower. Application of 90 kg N ha\(^{-1}\) in two equal splits (½ basal and ½ top dressing) or in two varied splits (2/3 as basal and 1/3 top dressing) recorded significantly higher LAI (Narasimha Rao and Narsa Reddy, 1982). Reddy et al. (1985) observed significantly higher LAI and DMP with split application of nitrogen. Nitrogen application at buttoning stage was found to promote growth of sunflower and also early translocation of photosynthates to reproductive parts (Krishna Reddy et al., 1992).

Application of half dose of nitrogen at basal and the remaining half nitrogen at 60 DAS produced higher dry weight of sunflower (Bindra and Kharwara, 1994). Reddy and Gajendra Giri (1996) observed that application
of nitrogen at 60 kg ha\(^{-1}\) in two splits, one at basal and the other at 25 DAS or three splits, the first at basal, the second at 25 DAS and the third at 50 DAS boosted the growth components compared to full basal application.

**Effect of split application of nitrogen on yield components and yield**

Split application of N produced bigger flower heads, more filled seeds head\(^{-1}\) and higher 1000 seed weight (Steer and Hocking, 1984). Head diameter and filled seeds head\(^{-1}\) were more with 60 kg N ha\(^{-1}\) applied half basal and one fourth at buttoning and the remaining one fourth at flowering (Krishna Reddy et al., 1992). Kharwara and Bindra (1992) reported that half the dose of N applied at the time of sowing and the remaining dose of N top dressed at 60 DAS significantly increased the yield components and seed yield of sunflower.

Basal application of half the recommended N at the time of sowing and the remaining half N in two equal splits at 20 DAS and at flower initiation had a marked effect on increasing the seed yield of sunflower (Haribabu and Chuhan, 1979). They also observed that with increased N application up to the level of 120 kg ha\(^{-1}\), the seed yield of sunflower was maximum and the yield increase was to the extent of 196 per cent over the control.

Application of 60 kg N ha\(^{-1}\) in three equal splits gave higher sunflower seed yield which was 23.7 and 12.5 per cent higher than that of entire basal and two split application respectively (Reddy and Gajendra Giri, 1997).

**Effect of split application of nitrogen on seed yield of sunflower**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean yield (q ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole basal</td>
<td>15.2</td>
</tr>
<tr>
<td>2 splits</td>
<td>17.1</td>
</tr>
<tr>
<td>3 splits</td>
<td>18.8</td>
</tr>
</tbody>
</table>

(Reedy and Gajendra Giri, 1997)

Kumar and Reddy (1997) found that application of 90 kg N ha\(^{-1}\) in three equal splits (at sowing, buttoning and flowering) in addition to basal application of P and K produced highest mean seed yield of 2.15 t ha\(^{-1}\). Similarly different time of N application increased the yield as reported by Rao *et al.* (1976); Rao and Reddy (1982). On the contrary, timing of nitrogen application had no effect either on seed yield or any of the seed quality characters (Nel *et al.*, 2000).

**Interaction effect of nitrogen and plant population**

Growth and growth components:

Shantamallaiah *et al.* (1977) revealed that sunflower plant height was maximum (153 cm) at 80 kg nitrogen with 40,000 plants ha\(^{-1}\). Karami (1980) observed that the growth of sunflower was good at 150 kg N ha\(^{-1}\) along with 50,000 plants ha\(^{-1}\). Narwal and Malik (1985) reported increased plant height with higher N dose at closer spacing of 45 x 20 cm. Plant height was maximum at higher level of N (80 kg ha\(^{-1}\)) with a plant spacing of 45 x 20 cm (Bhola and Faroda, 1990).

Singhi and Pacheria (1981) reported that the stem girth of sunflower was maximum (1.76 cm) at wider spacing (60 x 22.5 cm) with increased level of N (120 kg N ha\(^{-1}\)). However, increased plant population progressively decreased the stem girth at 0 to 80 kg ha\(^{-1}\) of N, but dry matter production were higher in lower plant populations with higher fertility levels (Hegde and Havanagi, 1987). Kene *et al.* (1993) and Tenebe *et al.* (1996) also reported that crop growth and dry matter accumulation of sunflower were higher at increased N and population levels.

**Yield components**

Head diameter: Ramaswamy *et al.* (1974) reported increased head diameter of sunflower at higher N (200 kg ha\(^{-1}\)) levels with lower plant population. Shantamallaiah *et al.* (1977) concluded that head diameter (21 cm) were high at 30,000 plant ha\(^{-1}\) with 80 kg N ha\(^{-1}\). Singh and Pacheria (1981) found that
lower plant population along with higher N level (80 kg N ha\(^{-1}\)) produced greater head diameter. Kene \textit{et al.} (1992) found that a plant spacing of 45 x 30 cm with 60 kg N ha\(^{-1}\) produced higher head diameter. Similar results were also reported by Shaik Mohammad and Sagar (1983).

**Number of filled seeds head\(^{-1}\):** Shantamallaiah \textit{et al.} (1977) reported that the filled seeds capitulum\(^{1}\) were maximum (877) at 30,000 plants ha\(^{-1}\) along with 80 kg N ha\(^{-1}\). Narasimha Rao and Narsa Reddy (1982) obtained more number of filled seeds under wider spacing at 90 kg N ha\(^{-1}\).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Percentage of filled seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 x 30 cm</td>
<td>85.78</td>
</tr>
<tr>
<td>45 x 30 cm</td>
<td>89.91</td>
</tr>
<tr>
<td>60 x 30 cm</td>
<td>89.14</td>
</tr>
<tr>
<td>CD</td>
<td>1.21</td>
</tr>
</tbody>
</table>

\textit{(Narasimha Rao and Narsa Reddy, 1982)}

Kene \textit{et al.} (1992) obtained more number of filled seeds in the presence of 40 kg N ha\(^{-1}\) with 45 x 30 cm spacing.

**Test weight:** Shaik Mohammad and Sagar (1983) found that wider spacing of 60 x 60 cm at higher level of N improved the 1000 seed weight upto 65.9 g compared to closer spacing as shown in the table.

<table>
<thead>
<tr>
<th>Spacing (cm)</th>
<th>Pooled mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 x 60</td>
<td>65.9</td>
</tr>
<tr>
<td>60 x 30</td>
<td>54.14</td>
</tr>
<tr>
<td>60 x 20</td>
<td>49.7</td>
</tr>
</tbody>
</table>

**Effect of spacing and nitrogen on 1000-grain weight (g) of sunflower**

\textit{(Shaik Mohammad and Sagar, 1983)}

Increasing N level upto 80 kg ha\(^{-1}\) with medium spacing of 45x30cm increased the test weight of sunflower (Bhola and Faroda, 1990).

**Seed yield:** Santamallaiah \textit{et al.} (1977) noticed higher seed yield (1020 kg ha\(^{-1}\)) at 60,000 plants ha\(^{-1}\) with 80kg N ha\(^{-1}\). However, increase in seed yield with 80 kg N ha\(^{-1}\) was not significant over 60kg N ha\(^{-1}\) at the same population level. Haribabu and Chauhan (1979) found that application of 120 kg N ha\(^{-1}\) in two splits with 60 x 22.5 cm spacing gave significantly higher yield than closer spacing. The yield components were found to increase with lower plant population and higher fertility levels (Hussein \textit{et al.}, 1980). This was mainly because of the fact that increase in seed weight and other components were compensated by more number of plants per unit area. Jadhawa and Jadhawa (1980) reported highest yield of sunflower at 45cm row spacing with 40kg N ha\(^{-1}\).

Singhi and Pacheria (1981) reported that adoption of 45cm row with 105 kg N ha\(^{-1}\) was better to get higher seed yield of sunflower. Higher seed yield (1921 kg ha\(^{-1}\)) was obtained with an interaction of 1,66,666 plants ha\(^{-1}\) and 80 kg N + 80 kg P\(_2\)O\(_5\) ha\(^{-1}\) as compared to 27,777 plants ha\(^{-1}\) without fertilizer (Hegde and Havanagi, 1987). Results of higher sunflower yield at higher plant population and fertility levels have also been reported by Srinivas and Patil (1977); Narwal and Malik (1986); Patil \textit{et al.} (1992).

Bhola and Faroda (1990) reported that 45 x 30cm plant spacing with 60 kg N gave the highest seed yield. This is in confirmity with the result obtained by Narwal and Malik (1985).

**Effect of nitrogen on seed yield of sunflower sown at 45x30-cm spacing**

\begin{tabular}{|c|c|}
\hline
Nitrogen level (kg/ha) & Seed yield (kg/ha) \\
\hline
40 & 1237 \\
60 & 1553 \\
80 & 1421 \\
CD & 105 \\
\hline
\end{tabular}

\textit{(Bhola and Faroda, 1990)}
Ujinaiah et al. (1991) observed that maintaining a row spacing of 60cm with 75kg N ha$^{-1}$ was ideal to produce good quality of BSH-1 seeds with high vigour-index. Bindra and Kharwara (1992) recorded higher seed yield of sunflower at 60 kg N ha$^{-1}$ with a plant spacing of 45 x 20cm. Similarly, increase in sunflower seed yield with N x plant population combination was reported by El-Sayed et al. (1984); Kene et al. (1993) and Bindra and Kharwara (1994).

Bhoite and Nimbalkar (1995) reported that sunflower seed yield was not affected by plant spacing but a positive interaction effect was observed with plant population and N and P nutrient levels. Tenebe et al. (1996) observed that interaction of N x plant population confounded the main effect of each factor on the yield of sunflower. They found that the seed yield (3425 kg ha$^{-1}$) obtained from the use of 100 kg N ha$^{-1}$ at 80,000 plant ha$^{-1}$ was significantly higher than those obtained from all other combination of N x plant population. The optimum plant population and N rate were 66,666 plants ha$^{-1}$ and 69kg N ha$^{-1}$, respectively for getting higher yield of sunflower as reported by Salehi and Bahrani (2000).

Massey (1971) in a study with graded doses of nitrogen (0, 56, 112 and 168 kg N ha$^{-1}$) at varied plant population levels (60,606, 30,303 and 19,762 plants ha$^{-1}$) noticed no significant interaction between N and plant population on any of the economical characters studied but individual effects of N and plant population were apparent. Singh and Kaushal (1975) also did not observe any significant interaction effect of nitrogen and plant population on seed yield of sunflower.

Seed protein and oil content

Srinivas and Patil (1977) revealed that the seed protein content increased from 21.65 to 24.25 per cent with increasing levels of N from 40 to 80 kg N ha$^{-1}$. An increase in N levels (0 to 200 kg N ha$^{-1}$) significantly reduced the percentage of oil in sunflower achenes (Karami, 1980). Similar results were also reported by Robinson et al. (1980).

Effect of N on nutrient uptake

Kalra and Tripathi (1980) found that sunflower crop removed 126.1, 29.8 and 82.8 kg of N, P and K ha$^{-1}$ respectively from soil, when applied with 120 kg N ha$^{-1}$. The total N uptake was higher (114.2 kg ha$^{-1}$) with 60 kg N ha$^{-1}$ as compared to without N (Krishnagowda, 1983). Application of N significantly increased the uptake of nutrients in both seed and stalk of sunflower (Haatouk and Latif, 1985 and Samui et al., 1987). The nitrogen uptake and soil mineral nitrogen was greater with 180-kg N ha$^{-1}$ compared to unfertilized control (De-Georgio et al., 1990).

Application of 120 kg N ha$^{-1}$ registered 87.1, 108.9 and 85.2 per cent increase in N, P and K uptake respectively by seed, compared to control (Sunil Kumar et al., 1991). Nitrogen application at higher doses increased N and P content at early growth stages only (Loubser and Human, 1993). Monoharan et al. (1991) reported that the uptake of N and P in sunflower increased with increasing levels of N. Sarmah et al. (1995) found that N uptake of sunflower was maximum with 80 kg N ha$^{-1}$. Mishra et al. (1995) inferred from a study in sandy loam soils at Bhuvaneswar that application of N upto 60 kg N ha$^{-1}$ increased the uptake of N, P and K by sunflower. Sivamurugan et al. (2000) observed that application of 80kg N ha$^{-1}$ recorded maximum nutrient uptake of 67.9 kg ha$^{-1}$. Legha and Gajendra Giri (2001) indicated that application of N (60 kg ha$^{-1}$) significantly enhanced the N uptake at all the stages of sunflower production.
REFERENCES