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# Impact of Nutrient Management and Agro-forestry Systems on Growth and Yield of Sunflower

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**A field experiment was conducted to evaluate the effect of integrated nutrient management (INM) practices on growth, yield parameters and yield of sunflower grown under neem (*Azadirachta indica*) and melia (*Melia azadirach*) trees during *kharif* 2009 at Student's Farm, College of Agriculture, Hyderabad. Dry matter production, crop growth rate, leaf area index, yield components and yield of sunflower was higher in sole cropping of sunflower compared to sunflower grown under neem or melia trees. Higher sunflower yield was recorded under sole cropping (560 kg /ha) compared to sunflower grown under neem and melia trees with yields of 461 and 317 kg /ha respectively. Application of subabul (*Leucaena leucocephala*) green leaf manure at 5 t / ha + 30 kg N/ha produced more growth, yield parameters, and yield of sunflower compared to other nutrient management practices. The studies suggested that sunflower was compatible with neem trees. However, melia trees had severe impact on growth, yield and yield parameters. Application of green leaf manure with half of recommended dose of nitrogen recorded better yield than recommended dose of nitrogen alone.**

**Key words**: Sunflower, agro forestry, INM practices, green leaf manuring, neem and *melia.*

Sunflower is an important oilseed crop, which is cultivated mainly under rainfed conditions (Anonymous, 2009) in India. Sunflower cultivation is becoming popular because of its special characteristics like short duration, photo thermo-insensitivity, suitability to year round cultivation and excellent quality edible oil. Modern management practices relies on chemical fertilizers and pesticides that has led to decline in soil organic matter, increased soil erosion and pollution of surface and ground water (Singh, 2000 and Relyea, 2005). The low productivity and risk are the other problems in the arable cropping system. High production cost and reliance on loans to purchase inputs are the major risk especially in rainfed areas where yields are uncertain (Eyhorn *et al.,* 2007)

The above said problem in arable farming especially in rain fed areas led to increased interest in agro-forestry system among different stakeholders. Agro forestry offers multiple opportunities to farmers for improving soil fertility, increasing farm productivity and income (Sharma *et al.,* 2009). On the other hand, integrated nutrient management using locally available resources such as organic manures and green leaf manure reduce the production cost and improve the resilience of the farm system by improving soil fertility in rain fed areas (Ravi and Divya, 2009: Sharma *et al*., 2009 and Panneerselvam and Bheemaiah 2005).

Further, it was observed that freely available eco-friendly tree leaves in conjunction with inorganic fertilizers have immense potential of supplementing a part of nitrogen and other nutrients through efficient mineralization to the associated crop in tree based cropping systems (Subba Reddy *et al.,* 1991). Therefore, keeping in view of the implications and the complexity of the tree crop interactions especially in agro forestry systems, the present study was initiated to find out the compatibility of sunflower intercropped with neem and melia trees under different nutrient management practices in rain fed area.

## Materials and Methods

A field experiment was conducted during kharif 2009 at College of Agriculture, Hyderabad to evaluate the effect of INM practices on growth, yield parameters and yield of sunflower intercropped with Azadirachta indica and Melia azadirach trees. The site of the experiment was under 5 years old neem trees and 6 years old Melia trees spaced at 4x3 m and 6 x 2 m, respectively. The treatments comprised of three cropping systems *viz*., intercropping of sunflower with neem (ICN), intercropping of sunflower with melia (ICM) and sole cropping of

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sunflower (SC) under main plot and nutrient management practices *viz.,* control ($T_1$), recommended dose of N 60 kg/ha ($T_2$), neem green leaf manure (GLM) 5t/ha + 30 kg N/ha ($T_3$), melia green leaf manure 5t/ha + 30kgN/ha ($T_4$), subabul green leaf manure 5t/ha + 30 kg N/ha ($T_5$), and farm yard manure 10 t/ha + 30 kg N/ha ($T_6$) under subplot and replicated thrice in a split plot design. The soil of the site was red sandy loam with medium in organic carbon (0.5%), available N (130 kg/ha), available P (20.3kg/ha) and K (195 kg/ha). The plot size was 6 x 4 square meter. Green leaf manure was obtained by lopping neem (N content 2.5%), melia trees (N content 2.3%) *in situ* while subabul leaves (N content 3.6%) were obtained by lopping nearby trees and required quantity of green leaf manure 5 t/ha and farm yard manure 10 t/ha (N content 0.5%) were incorporated into the soil 15 days before sowing of sunflower. Recommended dose of phosphorous *i.e.,* 60 kg/ha as single super phosphate was applied to all the plots for better decomposition.

Nitrogen was applied through urea at 30 days after sowing (DAS) in all the plots except control and also at sowing in $T_2$ treatment. The sunflower variety Morden was sown in 25.7.2002 at a spacing of 45 x 20cm in all the cropping systems. All the recommended package of practices was adopted for crop. The leaf area was measured with the help of LI-3100 leaf area meter by passing detached leaves, and leaf area index was calculated by dividing the total leaf area by ground area. Crop growth rate was (CGR) calculated from dry weight of the whole plant using the formula suggested by Watson (1958). Oil content in seeds of each treatment was estimated by Nuclear Magnetic Resonance (NMR) spectrometer as suggested by Tiwary *et al.* (1974).

## Results and Discussion

### *Growth parameters of sunflower*

Leaf area and leaf area index of sunflower was higher under neem intercropping system than the other two systems (Table1). Leaf area was higher by 14.9 and 65.3 per cent over sole cropping and melia intercropping system, respectively.

Among the INM practices, application of subabul GLM 5 t/ha + 30 kg N/ha ($T_5$) resulted in higher leaf area of 608 $cm^2$ and leaf area index (0.67) compared to other treatments (Table1).

**Table 1. Leaf area, LAI and dry matter production of sunflower as influenced by cropping systems and INM practices**

| Treatment | Leaf area (cm) | | | | Leaf area index | | | | Dry matter production (Kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean |
| $T_1$ | 214.9 | 130.6 | 228.7 | 191.4 | 0.238 | 0.144 | 0.253 | 0.212 | 797 | 555 | 903 | 752 |
| $T_2$ | 743.9 | 394.6 | 509.0 | 549.1 | 0.826 | 0.438 | 0.565 | 0.609 | 2955 | 2420 | 3318 | 2897 |
| $T_3$ | 634.1 | 351.5 | 564.1 | 516.5 | 0.704 | 0.390 | 0.626 | 0.573 | 2636 | 2141 | 3000 | 2592 |
| $T_4$ | 568.4 | 353.7 | 513.1 | 478.4 | 0.631 | 0.392 | 0.569 | 0.531 | 2490 | 1985 | 2639 | 2371 |
| $T_5$ | 731.7 | 489.4 | 605.2 | 608.8 | 0.813 | 0.543 | 0.672 | 0.676 | 2987 | 2380 | 3375 | 2914 |
| $I_6$ | 346.5 | 237.7 | 395.2 | 326.5 | 0.384 | 0.264 | 0.438 | 0.362 | 2262 | 1743 | 2617 | 2207 |
| Mean | 539.9 | 326.2 | 469.2 | | 0.599 | 0.362 | 0.520 | | 2354 | 1871 | 2642 | |
| | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | |
| Main | 13.7 | | 38.2 | | 0.016 | | 0.044 | | 84 | | 233 | |
| Sub | 25.1 | | 51.2 | | 0.028 | | 0.057 | | 78 | | 158 | |
| Main x Sub | 35.5 | | 75.3 | | 0.041 | | 0.087 | | 195 | | NS | |

ICN = Sunflower intercropped with neem; $T_1$ = Control
ICM = Sunflower intercropped with melia; SC = Sole cropped sunflower
$T_2$ = Recommended dose of N 60 kg/ha
$T_3$ = Neem GLM 5 t/ha + 30 kg N/ha
$T_4$ = Melia GLM 5 t/ha + 30 kg N/ha
$T_5$ = Subabul GLM 5 t/ha + 30 kg N/ha
$T_6$ = FYM 10 t/ha + 30 kg N/ha

Interaction effect between cropping system and INM practices had significant influence on leaf area and leaf area index. Higher leaf area (743 $cm^2$) and leaf area index (0.82) were recorded under the recommended dose which had increased leaf area of 245 per cent and 0.59 over control in neem intercropping system. However, it was on par with subabul GLM 5 t/ha + 30 kg N/ha. Similar trend was followed in sole cropped sunflower. Irrespective of the INM practices, lower values of leaf area and leaf area index was observed under melia intercropping systems.

Crop growth rate and dry matter production of sunflower was higher under sole cropping of sunflower compared to sunflower grown under neem and melia trees. However, leaf area and leaf area index were found to be higher under neem intercropping system. Growth parameters of sunflower were affected in melia intercropping system while neem intercropping system did not have much effect on sunflower. This trend was due to non competitive nature of neem with sunflower for nutrients and water because of deep root system and competitive nature of melia trees with sunflower for water and nutrients because of shallow root system. Similar results were reported in other studies on tree crop interaction (Leihnar *et al.,* 1996; Hazra and Tripathi, 1986; Sharma *et al.,* 1996; Sarada Devi, 1999)

**Table 2. Head diameter, head weight and 1000 seed weight of sunflower as influenced by cropping systems and INM practices**

| Treatment | Head diameter (cm) | | | | Head weight (g) | | | | Test weight (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean |
| $T_1$ | 7.23 | 6.36 | 8.20 | 7.26 | 12.43 | 10.43 | 15.40 | 12.75 | 27.03 | 25.13 | 28.96 | 27.04 |
| $T_2$ | 9.31 | 8.22 | 10.60 | 9.37 | 27.43 | 24.83 | 28.13 | 26.80 | 31.70 | 29.83 | 32.43 | 31.32 |
| $T_3$ | 8.60 | 8.00 | 9.96 | 8.85 | 27.00 | 23.93 | 27.63 | 23.85 | 31.10 | 30.03 | 32.20 | 31.11 |
| $T_4$ | 8.29 | 8.15 | 9.63 | 8.69 | 26.96 | 24.60 | 27.20 | 26.25 | 30.86 | 29.50 | 31.83 | 30.73 |
| $T_5$ | 9.52 | 8.50 | 11.00 | 9.67 | 27.80 | 25.90 | 28.06 | 27.26 | 31.40 | 29.96 | 32.73 | 31.36 |
| $T_6$ | 7.96 | 7.90 | 9.10 | 8.32 | 26.00 | 22.66 | 26.93 | 25.20 | 30.06 | 28.56 | 31.70 | 30.11 |
| Mean | 8.48 | 7.85 | 9.75 | | 24.61 | 20.89 | 25.56 | | 30.36 | 28.83 | 31.64 | |
| | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | |
| Main | 0.09 | | 0.27 | | 0.92 | | 2.57 | | 0.16 | | 0.45 | |
| Sub | 0.22 | | 0.45 | | 1.47 | | 3.00 | | 0.15 | | 0.32 | |
| Main x Sub | 0.26 | | NS | | 2.32 | | NS | | 0.38 | | 0.86 | |

ICN = Sunflower intercropped with neem; $T_1$ = Control
ICM = Sunflower intercropped with melia; $T_4$ = Melia GLM 5 t/ha + 30 kg N/ha
SC = Sole cropped sunflower
$T_2$ = Recommended dose of N 60 kg/ha
$T_5$ = Subabul GLM 5 t/ha + 30 kg N/ha
$T_3$ = Neem GLM 5 t/ha + 30 kg N/ha
$T_6$ = FYM 10 t/ha + 30 kg N/ha

Sunflower dry matter production was higher when grown as sole crop (Table1). However, dry matter production was higher under neem intercropping system compared to melia intercropping system. The reduction in dry matter production was by 10.9 and 29.1 per cent in neem and melia intercropping system, respectively as compared to sole cropping (2642 kg/ha).

Dry matter production of sunflower was higher in T5 (Subabul GLM 5 t/ha + 30 kg N/ha) and T2 (recommended dose of N 60 kg/ha). Subabul GLM 5 t/ha + 30 kg N/ha ($T_5$) produced 0.58, 12.4, 23, 32 and 287 per cent increase over recommended dose of N ($T_2$), neem GLM 5 t/ha + 30 kg N/ha ($T_3$), melia GLM 5 t/ha + 30 kg N/ha ($T_4$), FYM 10 t/ha + 30 kg N/ ha (T6) and control ($T_1$), respectively

Crop growth rate was higher at 30-60 days than 60 days harvest in all three systems. Crop growth rate of sunflower under sole cropping (4.0 g/m$^2$/day) was 20.8 and 58.1 per cent more than crop growth rate obtained under neem and melia intercropping systems, respectively at harvest (Fig1). Similar trend was observed at harvest. The maximum crop growth rate of sunflower was obtained with $T_2$ and $T_5$ treatments with values of 4.52 and 4.27 g/m$^2$/day which increased the CGR of sunflower by 322 and 299 per cent respectively over control (1.07 g/m$^2$/ day) at harvest. Similar trend was observed at 30-60days (Fig 2). Among the integrated nutrient management practices, Crop growth rate, leaf area, leaf area index and dry matter production of sunflower was higher under 30 kg nitrogen plus

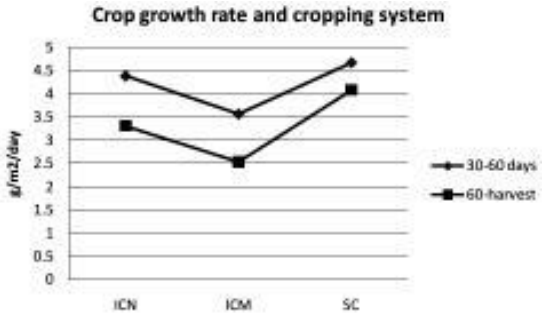


**Fig1. Sunflower crop growth rate (g/m$^2$/day) influenced by cropping systems at 30-60 DAS and 60 DAS-harvest**

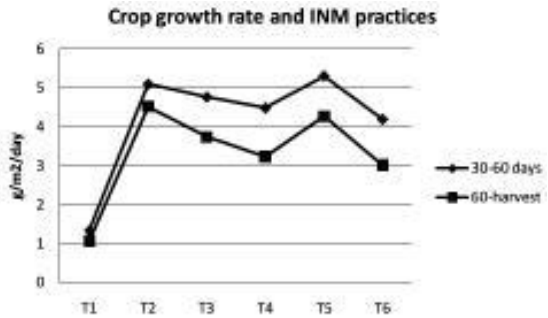


**Fig 2. Sunflower crop growth rate (g/m$^2$/day) influenced by INM practices at 30-60 DAS and 60 DAS-harvest**

subabul green leaf manure 5 ton per ha. Subabul green leaf manure was better than other green leaf manure. However, recommended dose of nitrogen was better than neem and melia green leaf manure. Subabul green leaf manure recorded high values of all the growth parameters which might be due to the higher concentration of nitrogen besides less fiber content in the leaves compared to neem and melia

leaves which led to timely decomposition and improved soil physical conditions. The other studies on integrated nutrient management using green leaf manure also reported that subabul green leaf manure was better than others (Madhusudan, 1997; Tripathi and Agarwal, 1988; Solomon and Bheemaiah, 2002)

***Yield components of sunflower***

Yield components like head diameter (9.75 cm), head weight (25.5 g), test weight (31.6 g) and yield per head (9.35 g) were found higher under sole cropping with an increase of 14.9, 3.65, 4.29 and 17.6 per cent, respectively, over neem intercropping system and 24.2, 22.5, 9.72 and 33.7 per cent, respectively, over melia intercropping system. Among intercropping systems, neem intercropping system resulted in better performance of sunflower in terms of yield components over melia intercropping system.

Integrated use of organic and inorganic sources of nitrogen like subabul GLM 5 t/ha + 30 kg N/ha, neem GLM 5 t/ha + 30 kg N/ha, melia GLM 5 t/ha + 30 kg N/ha and recommended dose of N 60 kg/ha resulted in higher yield components when compared with control. However, the increase under subabul GLM 5 t/ha + 30 kg N/ha treatment was 33.1, 114, 15.9 and 43.3 per cent of head diameter, head weight, test weight and yield per head, respectively, over control. Interaction effect did not influence the head diameter, head weight, and yield per head but, significantly affected the test weight of sunflower. Sole cropping with subabul GLM 5 t/ha + 30 kg N/ha application produced the higher test weight (32.7 g) with an increase of 13.1 per cent over control. Similar trend was observed under intercropping systems.

Cropping systems did not influence the oil content of sunflower. However, sole cropping recorded more oil content (33.3 %) followed by neem intercropping system (33.2%) and melia inter cropping system (32.4%) mainly because of better seed filling of sunflower due to increased stomatal conductance.

INM practices improved the oil content of sunflower substantially. However, all the treatments with green leaf manure incorporation have resulted in increased oil content of sunflower compared to control because of timely availability of nutrients to the sunflower.

***Yield of sunflower***

Seed yield of sunflower was significantly influenced by cropping systems (Table 3). Higher seed yield was recorded under sole cropping (560 kg /ha) than neem and melia intercropping system Seed yield of sunflower under sole cropping increased by 21.4 and 76.6% over neem and melia intercropping systems.

Application of nitrogen through organic and inorganic sources significantly influenced the seed yield of sunflower. Maximum seed yield (566 kg/ha) was obtained with subabul GLM 5t/ha + 30 kg N /ha ($T_5$) treatment. Interaction effects between cropping systems and INM practices were also found significant in respect of seed yield of sunflower. Higher seed yield of 710 and 688 kg/ha in $T_5$ and $T_2$ treatments respectively noticed over other treatments under sole cropping. Comparable yield was obtained with neem intercropping system at respective INM practices.

**Table 3. Yield per head, oil content and seed yield of sunflower as influenced by cropping systems and INM practices**

| Treatment | Yield per head (g) | | | | Oil content (%) | | | | Seed yield (kg/ha) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean | ICN | ICM | SC | Mean |
| $T_1$ | 6.56 | 4.94 | 7.26 | 6.25 | 30.60 | 30.80 | 31.50 | 30.96 | 116 | 65 | 142 | 107 |
| $T_2$ | 8.54 | 7.76 | 9.96 | 8.75 | 33.00 | 32.60 | 33.00 | 32.86 | 570 | 386 | 688 | 548 |
| $T_3$ | 8.35 | 7.54 | 9.78 | 8.55 | 34.20 | 33.10 | 34.10 | 33.80 | 523 | 366 | 639 | 509 |
| $T_4$ | 7.76 | 7.02 | 9.62 | 8.13 | 33.80 | 33.10 | 33.60 | 33.50 | 506 | 354 | 610 | 490 |
| $T_5$ | 8.83 | 7.89 | 10.16 | 8.96 | 34.00 | 33.50 | 34.30 | 33.93 | 582 | 407 | 710 | 566 |
| $T_6$ | 7.67 | 6.80 | 9.34 | 7.94 | 33.60 | 31.50 | 33.80 | 32.96 | 470 | 325 | 575 | 457 |
| Mean | 7.95 | 6.99 | 9.35 | | 33.20 | 32.43 | 33.38 | | 461 | 317 | 560 | |
| | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | | SEm± | | CD (P=0.05) | |
| Main | 0.11 | | 0.31 | | 0.32 | | NS | | 10 | | 28 | |
| Sub | 0.13 | | 0.27 | | 0.27 | | 0.56 | | 10 | | 21 | |
| Main x Sub | 0.27 | | NS | | 0.75 | | NS | | 24 | | 54 | |

ICN = Sunflower intercropped with neem; ICM = Sunflower intercropped with melia; SC = Sole cropped sunflower $T_1$ = Control; $T_2$ = Recommended dose of N 60 kg/ha; $T_3$ = Neem GLM 5 t/ha + 30 kg N/ha; $T_4$ = Melia GLM 5 t/ha + 30 kg N/ha; $T_5$ = Subabul GLM 5 t/ha + 30 kg N/ha; $T_6$ = FYM 10 t/ha + 30 kg N/ha

The impact of cropping systems and nutrient management practices on yield parameters was similar to that of growth parameters. Sunflower head diameter, head weight, test weight, yield per head, oil content and yield were higher when grown as sole cropping compared to intercropping. Melia trees had severe impact on yield and yield parameters of sunflower though neem had less effect. Poor growth of sunflower under melia tress due to more shading coupled with shallow root system resulted in poor yield parameters and yield. Previous studies also reported that melia based agro forestry system had harmful effects on yield and yield parameters of companion crops (Gillespie, 1989; Sarada Devi, 1999; Okorio *et al.,* 1994).

Among nutrient management practices, subabul green leaf manure with half dose of recommended

nitrogen recorded higher yield and yield parameters. Oil content was not influenced by green leaf manures treatment. The highest yield of sunflower was obtained under T5 treatment under sole cropping followed by recommended dose of nitrogen. Higher nutrient uptake and the resultant better growth of sunflower coupled with improved physiological parameters resulted higher yield parameters in subabul green leaf manure treatment (Malleswara Rao, 2002; Vani, 2001 Solomon and Bheemaiah, 2002)

## Conclusion

Based on the results of the experiment, it can be concluded that sunflower was compatible with neem trees and not with melia trees. Intercropping of sunflower with neem trees was comparable with sole crop of sunflower with respect to all parameters. However, melia trees had harmful effect on sunflower growth and yield parameters. It was also found that integrated nutrient management practices significantly influenced the growth, yield parameters and seed yield of sunflower crop. Further, the study revealed that conjunctive use of nitrogen with freely available tree leaves like neem, subabul had advantages in terms of enhancing crop yield and besides reducing risk of using external input in rain fed areas.

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