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# Nutrient Uptake, Yield and Economics of *Rabi* Sunflower as Influenced by Plant Density and Weed Management Practices

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**ABSTRACT**

A field experiment was conducted in *rabi*, 2009-10 at S.V. Agricultural College, Tirupati to study the nutrient uptake, yield and economics of *rabi* sunflower as influenced by plant density and weed management practices. The experiment was laid out in split plot design, replicated thrice with three plant densities *viz*., (1,11,111 plants $ha^{-1}$) 45 × 20 cm, (74,074 plants $ha^{-1}$) 45 × 30 cm and (55,555 plants $ha^{-1}$) 60 × 30 cm and seven weed management practices *viz*., unweeded check, weed free check, intercultivation at 30 DAS, intercultivation at 30 DAS + HW at 45 DAS, pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS, oxadiargyl @ 0.3 kg *a.i* $ha^{-1}$ + HW at 30 DAS and oxyflourfen @ 0.1 kg *a.i* $ha^{-1}$ + HW at 30 DAS. The lowest dry weight, nutrient uptake by weeds, the highest growth parameters, yield and economics were noticed with the plant density of 45 × 30 cm. Among the weed management practices tried, the lowest biomass of weeds and the highest growth parameters, yield and nutrient uptake by crop were resulted from pre-emergence application of pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS, besides weed free check. The nutrient uptake by weeds associated with the sunflower crop was 44.97, 16.33 and 44.27 kg $ha^{-1}$ of nitrogen, phosphorus and potassium respectively in unweeded check.

**Key words :** Nutrient uptake, Plant density, Sunflower, Weed Management, Yield.

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops in India and ranks second after soybean as a source of edible oil. Sunflower plays a crucial role in the oilseed economy of the country. India accounted for 3.26 % (1.04 m.t.) of the total world production of sunflower during 2009 and the average sunflower productivity (5.8 q $ha^{-1}$) in India is lower than the world average (13.41 q $ha^{-1}$) (FAO, 2010). Plant density affects the plant architecture and alters growth and developmental pattern of the crop. Maintenance of optimum plant density is one of the most important crop husbandry practices, which is responsible for the amount of radiation intercepted per unit area and significantly reduce the weed growth by reducing the availability of growth resources to the weeds. It is a well known fact that weeds compete with crop plants for nutrients, water, space and solar radiation resulting in significant yield reduction. The competition between crop and weeds for growth resources below as well as above the ground results in substantial reduction of crop yield. The reduction in seed yield of sunflower due to severe weed competition is to the extent of 58% (Daugovish *et al.,* 2003). The information available on the plant density and weed management in sunflower is limited. Of late, there is greater emphasis not to pollute the environment with indiscriminate use of chemicals and removal of weeds throughout the crop season may not be economical. Hence, it is necessary to integrate herbicides with other methods or switch over to alternative methods of weed control, which are eco-friendly. Hence, the present investigation "Nutrient uptake, yield and economics of *rabi* sunflower as influenced by plant density and weed management practices" was undertaken.

## MATERIAL AND METHODS

A field experiment was conducted during *rabi*, 2009-10 in sandy loam soil of Wetland Farm of S.V. Agricultural college, Tirupati. The experiment was laid out in a split plot design with three replications comprising three plant densities *viz.,* (1,11,111 plants $ha^{-1}$) 45 × 20 cm, (74,074 plants $ha^{-1}$) 45 × 30 cm and (55,555 plants $ha^{-1}$) 60 × 30 cm which were assigned to main plots and seven weed management practices *viz.,* unweeded check, weed free check intercultivation at 30 DAS, intercultivation at 30 DAS + HW at 45 DAS, pendimethalin 1.0 kg $ha^{-1}$ + HW at 30 DAS, oxadiargyl 0.3 kg $ha^{-1}$ + HW at 30 DAS and oxyflourfen 0.1 kg $ha^{-1}$ + HW 30 DAS were in sub-plots. The recommended dose of fertilizers applied to sunflower crop was 75 kg N, 90 kg $P_2O_5$ and 30

Table 1. Dry weight (g $m^{-2}$) and nutrient uptake of weeds at harvest of sunflower as influenced by plant density and weed management practices

| Treatment | Dry weight of weeds (g $m^{-2}$) | Nutrient uptake by the weeds (kg $ha^{-1}$) | | |
|---|---|---|---|---|
| | | Nitrogen | Phosphorus | Potassium |
| **Plant density** | | | | |
| 45 × 20 cm (1,11,111 plants $ha^{-1}$) | 45.22 (5.97) | 12.37 | 4.89 | 12.11 |
| 45 × 30 cm (74,074 plants $ha^{-1}$) | 41.78 (5.72) | 11.06 | 4.07 | 10.91 |
| 60 × 30 cm (55,555 plants $ha^{-1}$) | 48.80 (6.21) | 13.62 | 5.76 | 13.09 |
| CD (P=0.05) | 0.13 | 1.58 | 0.41 | 1.03 |
| **Weed management** | | | | |
| Unweeded check | 139.03 (11.80) | 44.97 | 16.33 | 44.27 |
| Weed free check | 0.00 (0.71) | 0.00 | 0.00 | 0.00 |
| Intercultivation at 30 DAS | 60.93 (7.83) | 15.47 | 6.67 | 17.53 |
| Intercultivation at 30 DAS + HW at 45 DAS | 49.21 (7.04) | 7.70 | 3.20 | 7.27 |
| Pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS | 21.49 (4.68) | 5.43 | 2.53 | 4.33 |
| Oxadiargyl @ 0.3 kg *a.i* $ha^{-1}$ + HW at 30 DAS | 23.70 (4.91) | 6.90 | 2.83 | 5.83 |
| Oxyflourfen @ 0.1 kg *a.i* $ha^{-1}$ + HW at 30 DAS | 22.51 (4.79) | 5.97 | 2.77 | 5.03 |
| CD (P=0.05) | 0.29 | 1.87 | 0.51 | 1.35 |
| Interaction effect | NS | NS | NS | NS |

Figures in parenthesis indicates square root ( $\sqrt{X+0.5}$ ) transformed values

kg $K_2O$ $ha^{-1}$. The entire dose of phosphorus and potassium and half of the nitrogen was applied as basal and the remaining half of the nitrogen was applied in two equal splits at 25 and 55 DAS as top dressing. The required quantity of herbicides were calculated and was mixed with water (600 l $ha^{-1}$) and sprayed uniformly with knapsack sprayer fitted with flat fan nozzle, one day after sowing as pre-emergence. Dry matter production of weeds and crop were recorded at the time of harvesting and the corresponding nutrient uptake was analyzed by adopting standard procedures. The data recorded on various parameters of crop, nutrient uptake and yield was subjected to statistical scrutiny by the method of analysis of variance as outlined by Panse and Sukhatme (1985). The data on dry weight of weeds were transformed to square root ( $\sqrt{X+0.5}$ ) transformation to normalize their distribution.

## RESULTS AND DISCUSSION

### Effect on weed

The major weed flora of the experimental field consisted of *Cynodon dactylon* (L) Pers., *Cyperus rotundus* L., *Celosia argentea* L. and *Digera arvensis* L.

The dry weight of weeds was significantly influenced by plant density and weed management practices and their interaction effect was found to

be non-significant (Table 1). Among the different plant densities tried, (74,074 plants $ha^{-1}$) 45 × 30 cm resulted in significantly the lowest dry weight of weeds. Higher plant population with this plant density, might have created better micro-environment to shift the balance in favour of crops and suppressed the weed growth and development. Further, crop plants would have smothered weeds, denying the light and space resulting in reduced weed dry weight. These results are in accordance with the findings of Pradeep and Sundaram (1996). Besides weed free check, total dry weight of weeds was significantly lesser with pre-emergence application of pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS, which was however, on par with pre-emergence application of oxyflourfen @ 0.1 kg *a.i* $ha^{-1}$ + HW at 30 DAS. Pre-emergence application of herbicides might have prevented the weed emergence at initial stages of the crop. However, both the weed management practices were more or less equally effective in suppressing the weed biomass production during the critical period of crop weed competition and these results are in accordance with Rathore and Gautham (2003).

The lowest nutrient uptake by weeds including nitrogen, phosphorus and potassium was observed with the plant density of (74,074 plants $ha^{-1}$) 45 × 30 cm, but for nitrogen, it was on par with (1,11,111 plants $ha^{-1}$) 45 × 20 cm. This might be due to reduction in dry weight of weeds in these plant densities. The results are in accordance with the findings of Sumathi *et al.* (2009). With regard to the weed management practices, nutrient uptake was the lowest with weed free check. The next best treatment was pre-emergence application of pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS. This might be due to better suppression of weed growth and reduced dry matter production by weeds. The nutrient uptake by weeds associated with sunflower crop was 44.97, 16.33 and 44.27 kg $ha^{-1}$ of nitrogen, phosphorus and potassium respectively in unweeded check. The results were in accordance with Kumara *et al.,* (2007). The interaction effect of plant density and weed management on nutrient uptake by weeds was found to be non-significant.

**Effect on crop**

The highest leaf area index and dry matter production of the crop were recorded with the plant density of (74,074 plants $ha^{-1}$) 45 × 30 cm (Table 2). This might be due to the higher number of plants per unit area producing more number of larger leaves, reduced mutual shading and made efficient utilization of underground resources by root system. These findings are in confirmity with those of Sarmah *et al.,* (1992). Among the weed management practices tried, weed free check resulted in the highest leaf area index and dry matter production than the rest of the weed management practices. The next best treatment was pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS, however, it was at par with oxyflourfen @ 0.1 kg *a.i* $ha^{-1}$ + HW at 30 DAS. This might be due to nearly weed free environment in these treatments which has facilitated better availability of nutrients and moisture for crop growth and development. The interaction effect of plant density and weed management practices did not influence the crop growth parameters significantly. The nitrogen uptake by the crop was highest with the plant density of (74,074 plants $ha^{-1}$) 45 × 30 cm, which was however, on par with (1,11,111 plants $ha^{-1}$) 45 × 20 cm, while the phosphorus and potassium uptake by the crop was significantly higher than with other plant densities. This might be due to lesser dry matter accumulation of weeds and higher crop dry matter production in the plant density of 45 × 30 cm. The results are in accordance with the findings of Sumathi *et al.,* (2009). The highest nitrogen uptake by crop was observed with weed free check, which was however, in parity with pre-emergence application of pendimethalin @ 1.0 kg *a.i* $ha^{-1}$ + HW at 30 DAS. Among the weed management practices tried, the phosphorus and potassium uptake by the crop was significantly higher with weed free check than the other weed management practices (Table 2). This might be due to increased dry matter accrual and corresponding nutrient content of tissues. This indicates that where the removal of nutrients by crop was higher, the corresponding uptake of nutrients by weeds was lesser and vice-versa.

**Yield and economics**

Achene yield of sunflower was significantly influenced by different plant density and weed management practices, while their interaction effect was found to be non-significant. The highest achene yield was noticed with the plant density of (74,074 plants $ha^{-1}$) 45 × 30 cm, this might be ascribed to elevated growth profile since germination, which led to maintenance of excellent source sink relationship. The results are in accordance with Sarmah *et al.,* (1992). Among the weed management practices tried, the highest achene yield was obtained with weed free check which was followed by pre-emergence application of pendimethalin @

Table 2. Growth, nutrient uptake, yield and economics of sunflower as influenced by plant density and weed management practices.

| Treatment | LAI | Drymatter production (kg ha$^{-1}$) | Nutrient uptake (kg ha$^{-1}$) | | | Achene yield (kg ha$^{-1}$) | Net Returns (Rs.ha$^{-1}$) | Benefit cost ratio |
|---|---|---|---|---|---|---|---|---|
| | | | Nitrogen | Phosphorus | Potassium | | | |
| **Plant density** | | | | | | | | |
| 45 × 20 cm (1,11,111 plants ha$^{-1}$) | 0.96 | 4024 | 41.5 | 14.7 | 49.2 | 1405 | 6917 | 1.36 |
| 45 × 30 cm (74,074 plants ha$^{-1}$) | 1.08 | 4230 | 43.1 | 17.1 | 51.6 | 1559 | 10299 | 1.57 |
| 60 × 30 cm (55,555 plants ha$^{-1}$) | 0.95 | 3800 | 39.5 | 13.2 | 47.9 | 1280 | 5478 | 1.29 |
| CD (P=0.05) | 0.05 | 130.7 | 2.5 | 0.4 | 1.7 | 94 | - | - |
| **Weed management** | | | | | | | | |
| Unweeded check | 0.38 | 2742 | 22.1 | 6.1 | 36.4 | 814 | -1567 | 0.90 |
| Weed free check | 1.23 | 4682 | 50.4 | 19.6 | 59.4 | 1852 | 13905 | 1.72 |
| Intercultivation at 30 DAS | 0.93 | 3698 | 33.8 | 12.1 | 42.3 | 1067 | 7092 | 1.14 |
| Intercultivation at 30 DAS + HW at 45 DAS | 0.99 | 3982 | 43.2 | 15.5 | 48.6 | 1488 | 9263 | 1.53 |
| Pendimethalin @ 1.0 kg *a.i* ha$^{-1}$ + HW at 30 DAS | 1.20 | 4470 | 48.2 | 18.1 | 56.4 | 1614 | 10623 | 1.58 |
| Oxadiargyl @ 0.3 kg *a.i* ha$^{-1}$ + HW at 30 DAS | 1.10 | 4214 | 44.6 | 16.3 | 49.8 | 1511 | 8243 | 1.44 |
| Oxyflourfen @ 0.1 kg *a.i* ha$^{-1}$ + HW at 30 DAS | 1.14 | 4339 | 46.9 | 17.4 | 53.1 | 1557 | 10123 | 1.56 |
| CD (P=0.05) | 0.08 | 175.1 | 2.4 | 1.3 | 3.2 | 72 | - | - |
| Interaction effect | NS | NS | NS | NS | NS | NS | - | - |

1.0 kg *a.i* ha$^{-1}$ + HW at 30 DAS. This was due to lesser crop weed competition for growth resources throughout the crop growth period, which would have provided congenial environment for better expression of growth and yield potential. Similar findings were reported by Poonguzhalan *et al.*(2002). The highest net returns (Rs. 10299 ha$^{-1}$) and benefit cost ratio (1.57) were recorded with the plant density of (74,074 plants ha$^{-1}$) 45 × 30 cm. Among the weed management practices tried, the highest net returns (Rs. 13905 ha$^{-1}$) and benefit-cost ratio (1.72) were recorded with weed free check, which was followed by the pre-emergence application of pendimethalin @ 1.0 kg *a.i* ha$^{-1}$ + HW at 30 DAS with net returns of Rs. 10623/- and benefit-cost ratio of 1.58. While, the unweeded check rendered net returns of Rs. -1567/- and benefit-cost ratio of 0.90.

Thus, the plant density of (74,074 plants ha$^{-1}$) 45 × 30 cm coupled with weed free check resulted in the highest nutrient uptake, achene yield, and economic returns from sunflower. However, the next alternative weed management practice without draining either economic yield or the net profit is pre-emergence application of pendimethalin @1.0 kg *a.i* ha$^{-1}$ + HW at 30 DAS.

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