ladras Agric. J. 91 (7-12) : 365-369 July-December 2004
https://doi.org/10.29321/MAJ.10.A00115

nfluence of plant population and N splits on seed, oil yield and economics if rainfed sunflower (*Helianthus annuus* L.)

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Abstract: Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore, during the Northeast monsoon (October – December) seasons of 1997 and 1988 in split plot design to study the influence of plant population and N splits on seed, oil yield and economics of rainfed sunflower (*Helianthus annuus* L.). The main plot consisted of three plant poulations (1,33,333 plants ha^{-1}, 1,11,111 plants ha^{-1} and 88, 888 plants ha^{-1}) and the sub – plot treatments of six N split – levels. The results revealed that the seed, oil yield and economic return were higher at closer (30x25 cm) spacing in 1997 and at wider spacing (30 x 37.5 cm) in 1998 due to wider variation in rainfall distribution. In both years the spilt application of nitrogen resulted in higher seed, oil yield and economic return when compared to full basal application.

Key words: Sunflower, Plant population, N splits, Seed yield, Oil yield and economics

Introduction

Sunflower is an important oil seed crop in arid and semi-arid regions, ranking third in the world after soybean and groundnut in edible oil production. Being a photo insensitive crop, sunflower has a wide range of adaptability to different agro climatic conditions. However, under rainfed conditions where soil moisture is a limiting factor, maintaining an optimum plant population by adopting appropriate crop geometry is an important optimum factor in increasing yields (Subba Reddy *et al.* 1997). Yield could be further increased by the application of fertilizer, particularly nitrogen (Tenebe *et al.* 1996). Here again the nitrogen needs to be applied in split doses in order to meet the requirements at critical stages of crop growth, which would promote the seed yield and in turn the oil yield of sunflower (Krishna Reddy *et al.* 1992). It was against this background that the field investigation was carried out under rainfed conditions to study the influence of plant population and split application of nitrogen on sunflower.

Materials and Methods

Field experiments on sunflower were carried out at Tamil Nadu Agricultural University, Coimbatore, during the Northeast monsoon (October – December) season of 1997 and 1998 to find out the influence of plant population and N splits on seed, oil yield and economics of rainfed sunflower. The soil of the experiment field was low in available N (210 kg N ha^{-1}), medium in available P (17.5 kg P_2O_5 ha^{-1}) and high in available K (460 kg K_2O ha^{-1}). The electrical conductivity of the soil was 0.42 dSm^{-1} and thr pH was 8.2. The sunflower variety CO2, with field duration of 87 days, was used in the trail. The seeds were sown by dibbling 2 to 3 seeds hill^{-1} in a flat bed with a row spacing of 30 cm and plant spacing as per the treatment schedule.

The experiments were laid out in a split plot design replicated three times. The treatment details were as follows:

Table 1. Influence of plant population and split application of N on seed, oil and straw yield of rainfed sunflower.

Treatments	Seed yield (kg ha^{-1})		Oil yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Oil content (%)	
	1997	1998	1997	1998	1997	1998	1997	1998
P1	741	1022	274.5	374.7	4063	3524	37.05	36.70
P2	757	953	281.4	349.8	4217	3802	37.17	36.74
P3	810	838	301.2	305.8	4963	4587	37.18	36.79
SEd	8	4	5.4	16.3	80	47	0.09	0.07
CD (P=0.05)	24	11	14.8	43.9	223	130	NS	NS
N1	730	938	271.8	345.0	3789	4094	37.23	36.8
N2	762	998	282.9	361.0	4252	4315	37.13	36.2
N3	746	883	276.9	331.0	4520	3520	37.12	37.5
N4	812	932	301.0	337.5	4480	3871	37.01	36.2
N5	774	911	288.1	338.9	4688	3826	32.20	37.2
N6	792	964	293.8	347.7	4757	4196	37.10	36.1
SEd	21	6	11.0	8.3	79	71	0.16	0.90
CD (P=0.05)	42	13	22.1	16.8	162	144	NS	NS

Table 2. Influence of plant population and split application of N on economics of rainfed sunflower

Treatments	Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	1997	1998	1997	1998	1997	1998
P1	7410	10200	4293	7071	2.38	3.25
P2	7570	9530	4438	6369	2.42	3.01
P3	8100	8380	4948	5203	2.57	2.64
N1	7300	9380	4214	6264	2.37	3.01
N2	7620	9980	4498	6829	2.44	3.17
N3	7460	8830	4338	5679	2.39	2.80
N4	8120	9320	4963	6134	2.57	2.93
N5	7740	9110	4583	5924	2.45	2.86
N6	7920	9640	4763	6454	2.51	3.03

I Main Plot: *Plant Population*

- P_1 : 80% of recommended plant population (30 X 37.5 cm)
- P_2 : 100% of recommend plant population (30 X 30 cm)
- P_3 : 120% of recommended plant population (30 X 25 cm)

II Sub plot: *Nitrogen split application*

- N_1 Full basal (40 kg N ha^{-1})
- N_2 ½ basal + ½ in the 4th week after sowing with rain
- N_3 ½ basal + ½ in the 6th week after sowing with rain
- N_4 ½ basal + ½ in the 4th week after sowing + ¼ in the 6th week after sowing with rain

N_5 ½ basal + 1/3 in the 4th week after sowing + 1/3 in the 6th week after sowing with rain

N_6 ¼ basal + ½ in the 4th week after sowing + ¼ in the 6th week after sowing with rain

The time fertilizer application was fixed based on the simple water balance model results. Fertilizer was scheduled, to be applied only when there is greater chance for getting 15mm of rainfall or more, during that particular week and soil moisture is sufficient enough. During 1997 a total rainfall of 21.9 mm and 45.5 mm were received during the 4th and 6th week after sowing and corresponding mean soil available moisture on 4th and 6th week was 3.6 mm and 44.8 mm, respectively.

Of the recommend rate of N,P and K at 40: 20: 20: kg ha^{-1} nitrogen was applied in splits as per the treatment schedule, the entire doses of P_2O_5 and K_2O were applied basely to all the treatments. The amount of rainfall received during the cropping period was 598 mm and 571 mm distributed over 43 and 20 rainy days during 1997 and 1998, respectively. The seed yield from each net plot area was recorded at 14% moisture level and expressed in kg ha^{-1}. The oil content of the seed was estimated using a Nuclear Magnetic Resonance (NMR) spectrometer (Bruter Minispe P20 model) against a standard reference sample (Granlund and Zimmerman, 1975). The data recorded were analyzed statistically following the procedure given by Gomez and Gomez (1984). Since the study was conducted under rainfed conditions and the distribution of rainfall differed widely between the years (1997 and 1998), pooled analysis of data was not done and only the data for individual years are presented and discussed.

Results and Discussion

Influence of plant population on seed, oil and straw yield

The various spacing tested in both years significantly influenced the sunflower seed, oil and straw yield. A closer spacing of 30 x25 cm (1,33,333 plants ha^{-1}) gave a significantly higher yield than wider spacing of 30 X 30 cm and 30 X 37.5 cm in 1997. Though the yield attributes had higher values on a per plant basis under the widest plant spacing of 30 X 37.5 cm, the yield was higher under closer spacing due to the more number of plants ha^{-1}. The increased plant population per unit area compensated the percentage yield loss due to competition at higher density. The higher values of yield components at greater plant density were the result of the better utilization of rainfall in a favourable environment and effective moisture utilization during high rainfall (Reddy and Gajendra Giri, 1997). During 1998, the increase in yield parameters at the lowest plant density of 88,888 plants ha^{-1} produced a higher seed yiel on a per hectare basis. The spacing of 30 x 37.5 cm gave significantly higher seed yield when compared to closer spacing 30 x 30 and 30 x 25 cm. This may possibly be due to the severe competition between the plants under closer spacing, especially during the moisture stress experienced in the vegetative and early in the cropping period of 1998 (571mm) was 78% higher than the normal seasonal rainfall of 321 mm, the distribution was not uniform since there was higher intensity of rainfall on a smaller number of rainy days. This situation led to greater soil moisture deficit at higher plant population levels because of greater competition between the plants. It was also evident from other studies on sunflower that in relatively dry years an increased plant population cannot complete with the yields obtained at lower plant densities on a per plant basis (Dhoble *et al.* 1988). Rao and Reddy (1995) also reported the advantages of sub optimal plant populations under stress conditions. Higher seed yield on per hectare basis and more oil content might be the reason for increased oil yield in both the year.

The straw yield was significantly higher under the closure spacing of 30x25 cm (1,33,333 plants ha-1) when compared to other two plant population levels (1,11,111 plants ha-1 and 88,888 plants ha-1) irrespective of years of study. This may be due to higher dry matter accumulation under higher plant density in both favorable and unfavorable seasons. Even though the soil moisture stress at vegetative and early reproductive stages during 1998 restricted the synthesis of assimilates in storage organs (the captimum), the total dry matter accumulated in the leaves and stem were not affected indicating that sunflower is highly flexible in producing total dry matter rather than the dry matter production accumulated for the captimum alone. Similar results of increased stalk yield with higher plant density under rainfed situation were reported by Umrani and Bhoi, (1985).

Influence of split application of N resulted in significant improvement in the seed yield of sunflower. The application of nitrogen in three splits (1/2 basal + ¼ in the 4th week after sowing + ¼ in the 6th week after sowing with rain) increased the seed yield (812 kg ha-1) by 11.2% over the seed yield (730- kg ha-1) of full basal application of N (Table 1). The higher seed yield obtained with split application of N was due to better growth and yield attributes of sunflower in the favourable monsoon seasons in the year 1997, where there were fewer dry spells during the crop season. The better translocation of photosynthates to the reproductive parts was responsible for the improvement in the yield attributes and yield of sunflower (Reddy and Gajendra Giri,1997). However, in 1998 the application of nitrogen in two equal splits (1/2 basal + ½ in the 4th week after sowing with rain) resulted in 9.53% higher seed yield (998 kg ha-1) compared with the seed yield (932 kg ha-1) of three split application of N (1/2 basal + ¼ in the 4th week after sowing + ¼ in the 6th week after sowing with rain) (Table 1). This might be due to intermittent dry fells after the 4th week, which created a soil moisture deficit resulting in reduced nutrient uptake by sunflower at the active vegetative and flowering stages, leading to a reduced seed yield in the three – split N application.

Application of nitrogen in three split (1/4 basal + ½ on 4th week after sowing + ¼ on 6th week after sowing) produced 25. per cent greater stalk yield than full basal application. Split application of nitrogen a flowering could accumulate more food materia because of effective nitrogen utilization unde adequate moisture conditions (Jayaraman, 1988). When the rainfall is more frequent, split applicatio of nitrogen could avoid various types of N losses. In 1998, nitrogen application in two equal splits (1/2 basal + ½ on 4th week afte sowing with rain) had 22.6 per cent highe stalk yield than nitrogen applied in two equa splits (1/2 N basal + ½ on 6th week afte sowing). This indicated that in 1998 the cro might have suffered due to water stress induce nitrogen stress at late vegetative and early floweri stages. Though during 1998 the terminal fa sunflower of crop has received above norm rainfall, which soaked soil thoroughly, the lo occurred due to water and nutrient stress a critical stages could not be compensated.

In 1997, highest benefit: cost ratio was observed that in the treatment combination of higher plant population with three nitrogen split application. But in 1998, lower plant population with two equal spits before 30DAS (1/2 basal + ½ on 4th week after sowing) with receipt of rainfall recorded higher net return and benefit: cost ratio (Table 2). The difference in net return and B:C ratio between the treatments was caused only by the variation in seed yield in both the years.

From the study, it is concluded that the highest plant population of 1,33,333 plants ha-1 combined with in 3 splits (1/2 N basal + ¼ in the 4th week after sowing + ¼ in the 6th week after sowing with rain) was best for obtaining higher yields in sunflower under rainfed conditions with a high, uniform distribution of rainfall. However, when there is moisture stress in the vegetative and flowering stages due to the uneven distribution of rainfall, the lowest plant population of 88,888 plants ha-1 combined with recommended N in 2 splits

1/2 + ½ in the 4th week after sowing with ain) was found to be the best treatments for btaining higher seed, oil and straw yield and conomic return in rainfed sunflower.

leference:

Dhoble, M.V., Thete, M.K. and Khating, E.A. (1988). Effect o row and plant spacing on yield of sunflower varieties under dryland conditions. *Indian J. Dryland Agric. Res. and Dev.*, **3:** 49-57.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. An International Rice Research Institute Book. A Wiley – Interscience Publication, John Wiley and Sons, Inc., New York.

Granlund, M. and Zimmerman, D.C. (1975): Effect of drying conditions on oil content of sunflower (Helianhus annuus L.) seeds as determined by wideline nuclesr magnetic resonance (NMR). N.D. *Acad. Sci. Proc.*, 27 (Part 2). *North Dakota Acadamy of Sci., Grand Forks, ND,* pp.128-132.

Jayaraman, S. 1988. Nitrogen management in high yielding cotton under rainfed conditions. *Indian J. Agron.* **33:** 456-457.

Krishna Reddy, S.V., Husain, M.M., Kasthuri, K., Reddy, B.B and Reddy, G.V. (1992): Effect of soil and foliar application of nitrogen in sunflower (Helianthus annuus) under rainfed condition. *Indian J. Agron.*, **37:** 863-865.

Rao, T.T. and Reddy, S.C. (1995). Effect of phosphorus levels at different plant densities on the yield attributes for sunflower (*Helianthus annuus* L.) J. *FMG. System,* **1:** 44-47.

Reddy, G.P. and Gajendra Giri. (1997). Influence of time of seeding, pollination and nitrogen split application on yield of sunflower. *Indian J. Agron.* **42:** 506-511.

Subba Reddy, G., Maruthi, V., Gangadhar Rao, D. and Vanaja, M. (1997). Effect of plant density and moisture stress on productivity of sunflower. *Ann. Agric. Res.* **18:** 482-487.

Tenbe, V.A., Paul, U.R., Okonkwo, C.A.C and Avwalu, B.M. (1996): Response of rainfed sunflower to nitrogen rates and plant population in semi arid savannah regions of Nigeria. *J. Agron. and Crop Sci.,* **177:** 207-215.

Umrani, N.K. and P.G. Bhoi.(1985). Performance of sunflower as influenced by plant density under drylands. *J. Mharashtra Agric. Univ.*, **10:** 34-35.

(Received: June 2003; Revised: May 2004)