International Journal of Plant & Soil Science

Volume 35, Issue 24, Page 1-7, 2023; Article no.IJPSS.110303
ISSN: 2320-7035

Planting Geometry and Nutrient Management on Productivity and Quality of Rainfed Sunflower in Deep *Vertisol* of Northern Karnataka, India

Umesh, M. R. [a*], Shanwad U. K. [b], V. N. Ghante [a], Vikas V. Kulkarni [a] and Poornima [a]

[a] AICRP on Sunflower, MARS, University of Agricultural Sciences, Raichur, Karnataka, India.
[b] Department of Agronomy, University of Agricultural Sciences, Dharwad, Karnataka, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i244290

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/110303

Original Research Article

Received: 04/10/2023
Accepted: 11/12/2023
Published: 24/12/2023

ABSTRACT

Maintenance of optimum population and balanced fertilizer application are most critical to achieve greater productivity of sunflower under rain-fed condition. Experiment was conducted during *Kharif* 2015, 2016 and 2017 to know the response of rainfed sunflower by varying planting geometry and fertilizer levels under different land configurations. Results showed 31.7% higher seed yield by seeds planting on ridges and furrows at 60 cm x 30 cm over flatbed sowing at 60 cm x 30 cm. Further, yield improvement upto 20.9% was observed by application of additional 50% RDF as compared to 75% RDF. However, application of 125% RDF was found on par with the application of RDF. Economic returns in terms of gross returns (Rs. 63539/ha), net returns (Rs. 37601/ha) and B:C ratio (2.48) was higher from ridge and furrow sowing at 60 cm x 30 cm followed by broad bed

**Corresponding author: E-mail: mrumeshagri@gmail.com; mrumeshagri@uasraichur.edu.in;*

and furrow with paired row planting at 45 cm x 40 cm. Among fertilizer levels, application of 125% RDF recorded higher monetary returns and B: C ratio comparable with application of 100% RDF. Results confirmed that sunflower planted on ridges and furrows at 60 cm x 30 cm was found to enhance yield and economics than existing traditional method of flatbed sowing at 60 cm x 30 cm spacing. Further, sunflower yield improvement was also observed by application of graded fertilizers of 25% higher than existing recommendations.

Keywords: Broad bed and furrow; land configuration; paired row; planting geometry; sunflower; vertisol.

1. INTRODUCTION

The sunflower (*Helianthus annuus* L.) is one of the most economically important edible oil-producing crop in the world. It is highly promising for around-the-year cultivation under different agro-climatic regions owing to its thermo-photo-insensitivity. Major advantage of sunflower is short duration, day neutral, suitable to varied soil types, it has potential to yield 2-2.5 tonnes/ha seed yield. Over the years, productivity of sunflower in India has remained around 850 kg ha^{-1} [1]. It is much lower compared to world average productivity of 1.3 tonnes/ha, due to lack of sound scientific management practices. Among the various reasons for low productivity, one finds the soil moisture stress, role of plant nutrients. Further, its yield potential is very low under rainfed tropical ecosystem. There is a need to improve the productivity and sustainability of sunflower under rainfed conditions by improving the rainwater use efficiency with suitable moisture conservation practices and optimal input fertilizers [2]. There is ample scope of increasing production by use of good agronomic practices (GAP) as well as proper fertility management [3].

Since planting geometry determines the distribution pattern of plants over a field, it directly affects solar energy interception and evaporation and indirectly affects water use efficiency. Proper placement of plants over a given area makes plant canopy more effective in intercepting radiant energy [4]. *C*onventionally, the sunflower is grown on flat planting without taking care of its planting time under rainfed. Apart from planting time, method and row spacing would play vital role in improving sunflower productivity. Likewise, sunflower response to row plasticity was also demonstrated by Lopez Pereira and Hall [5]. The innovative farmers' modification was testing ridge and early planting. Ridge sown sunflower had higher seed and oil yields than sunflower sown on furrows or flatbeds [6,7]. The objective of this field study was to determine the impact of land configurations, sowing method along with fertilizer rate on seed yield, oil content and economics of rainfed sunflower in *Vertisol*.

2. MATERIALS AND METHODS

A field experiment was conducted at Main Agriculture Research Station, Raichur, University of Agricultural Sciences, Raichur (16°12' N 77° 19'3 E, 407 m elevation) Experiment was conducted under rainfed during rainy seasons of 2017, 2018 and 2019. The climate of the region is semi-arid and subtropical. The soil of the area was medium to deep black, low in organic carbon (0.36 %), high in available P_2O_5 (45 kg ha^{-1}) and available K_2O (536 kg ha^{-1}). The experiment was laid out in a split plot design replicated thrice. Seeds were hand dibbled manually on half way mark of the ridges. The main plots consisted of flatbed sowing at 60 cm x 30 cm, ridge and furrow sowing at 60 cm x 30 cm, flat bed with paired row sowing at 45 cm x 30 cm (90/40 cm) and broad bed and furrow with paired row sowing at 45 cm x 30 cm (90/40cm). Sub plot treatments consists of 75% RDF, 100% RDF (90:90:60 N, P_2O_5 and K_2O kg ha^{-1}) and 125% RDF. Sunflower hybrid RSFH-1887 was sown on 2nd week of July and harvested duirng 4th Week of October in all the years of study. As per the treatments were received 90 kg P_2O_5 and 60 kg K_2O along with 45 kg N at sowing. The rest of the 45 kg N was applied at 30 and 55 DAS. Weeds were managed by application of Pendimethalin 38.7 CS @ 0.75 kg a.i./ha on the day of planting. Intercultural operation was done at 30 DAS for further weed control. Throughout the cropping period no irrigation water was provided. Plant protection measures were done as and when pests and diseases incidence was above the threshold. Different growth parameters of sunflower were differed significantly due to land configuration and fertilizer levels in *Vertisol* at Raichur. Economics of the study was worked out by considering prevailed market price of sunflower seeds during the study year. Data

collected were statistically analyzed in OPSTAT computer programme using the Fisher's analysis of variance technique and LSD test at 5% probability was used to compare the differences among treatments' means.

3. RESULTS AND DISCUSSION

3.1 Weather and Crop Growth

Data on rainfall, daily minimum and maximum temperatures are presented in Fig. 1. The distribution of rainfall in each are varied across the years. Rainfall received during 2016, 2017 and 2019 was 561, 669 and 568 mm respectively. It was 9.5%, 30.7% and 10.9% higher than normal rainfall (512.2 mm). In addition, number rainy days (>2.5mm) in 2016, 2017 and 2019 were 23, 34 and 36 days respectively. These were much lower than normal rainy days of 42 of the region. Distribution of rainfall was uniform in 2019 as compared to other two years. For rainfed sunflower intensity and distribution of rainfall during cropping period was also found important. The years also differed little in seasonal mean maximum (30.0-31.5°C) and minimum (20.0-22.3°C) temperatures. Temperatures in the region are generally higher from March to June.

3.2 Growth Attributes

Plant height of sunflower was significantly influenced by land configuration and rate of fertilizer application and its interaction effect (Table 1). Significantly taller plants were recorded in ridges and furrow method of planting and dwarf plants in farmers' practice of flatbed sowing. Graded levels of fertilizer application at 125% RDF recorded taller plants and drastically reduced at lower rates. Interaction effect of land configuration and fertilizer rates was found non-significant on plant height of sunflower.

Land configuration had no significant effect on sunflower head diameter, seed coil content at maturity (Table 1). While, 100 seed weight, seed yield and oil yield were affected by land configuration it was higher in ridges and furrow at 60 cm x 30 cm. These were lowest in farmer's practice of flatbed sowing. Paired row planting had no significant effect on various yield attributes of sunflower.

Higher rate of fertilizer at 125% RDF has recorded greater head diameter, 100 seed weight and seed yield per plant as compared to 75 and 100% RDF. Interaction effect of fertilizer rate and land configuration was found non-significant. Individual seed weight indicated by 100 seed weight was significantly influenced by land configuration and rate of fertilizer application. Increase in head diameter was due to increased fertilization levels this could be the effect of higher nutrients on growth, seed yield and its attributes.

Seed yield was significantly influenced by land configuration and fertilizer levels (Table 1). Data over three years, dibbling of seeds on ridges and furrows (1856 kg ha^{-1}) had significant effect on seed yield as compared to regular or paired row flatbed sowing. The yield improvement was 23.7 to 31.7% respectively. Application of 25% higher fertilizer has resulted yield improvement of 8.1% (133 kg ha^{-1}) over present recommended rate. Further yield was reduced by lower fertilizer rate at 75% RDF application (13.97%). However interaction effect was found non-significant. Seed oil content was found non-significant either by land configuration and fertilizer rate. However, oil yield improvement was observed in ridges and furrow planting (628.7 kg ha^{-1}) as compared to present practice of flatbed sowing (471 kg ha^{-1}). Further significant improvement in sunflower oil yield was observed by fertilizer application at 125% RDF (596.3 kg ha^{-1}) over 100% and 75% RDF (Table 1). Pavani et al. [8] showed that fertilizer rate has significant effect on seed yield and economics of sunflower production. Further, ridges and furrows would serve as moisture conservation practice during low rainfall condition whereas drainage channel during heavy rainfall events. Guled et al. [9] also realized the ridges and a furrow was best way to conserve moisture in rainfed sunflower. At same experimental site, Sneha et al. [10] also showed significant effect of planting density on yield traits, seed and yield of sunflower. Results of other trials reported by Prabhakar et al. [6], Let et al. [2] showed increased sunflower yield attributes by higher rate of fertilizers.

3.3 Economic returns

Improvement in grain yield thus also reflected on economic returns from sunflower production. Due to additional cost towards making ridges and furrows cost of cultivation relatively higher than flatbed sowing. Further higher rate of fertilizer application has also resulted higher cost of production. Averaged over three years, net economic returns were greater in sunflower planting on ridges and furrows over other land

configuration. It has resulted in additional returns of Rs. 13662/ha over flatbed method of planting. While higher rate of fertilizer application has resulted higher economic returns over lower rates (Table 2). Application of 25% higher fertilizer has resulted additional return of Rs. 2205 in spite of higher cost of cultivation for the same treatment. Differences in grain yield levels were responsible for variation in economic returns even though variation in cost of production. Marginal difference in B: C ratio was recorded with the application of higher levels of nutrients (2.22) over RDF (2.25). greater economic returns from rainfed sunflower by change in planting method and graded fertilizer application was reported by Prabhakar et al. [6]; Let et al. [2]; Sardana and Bajaj [11], [12,13-16].

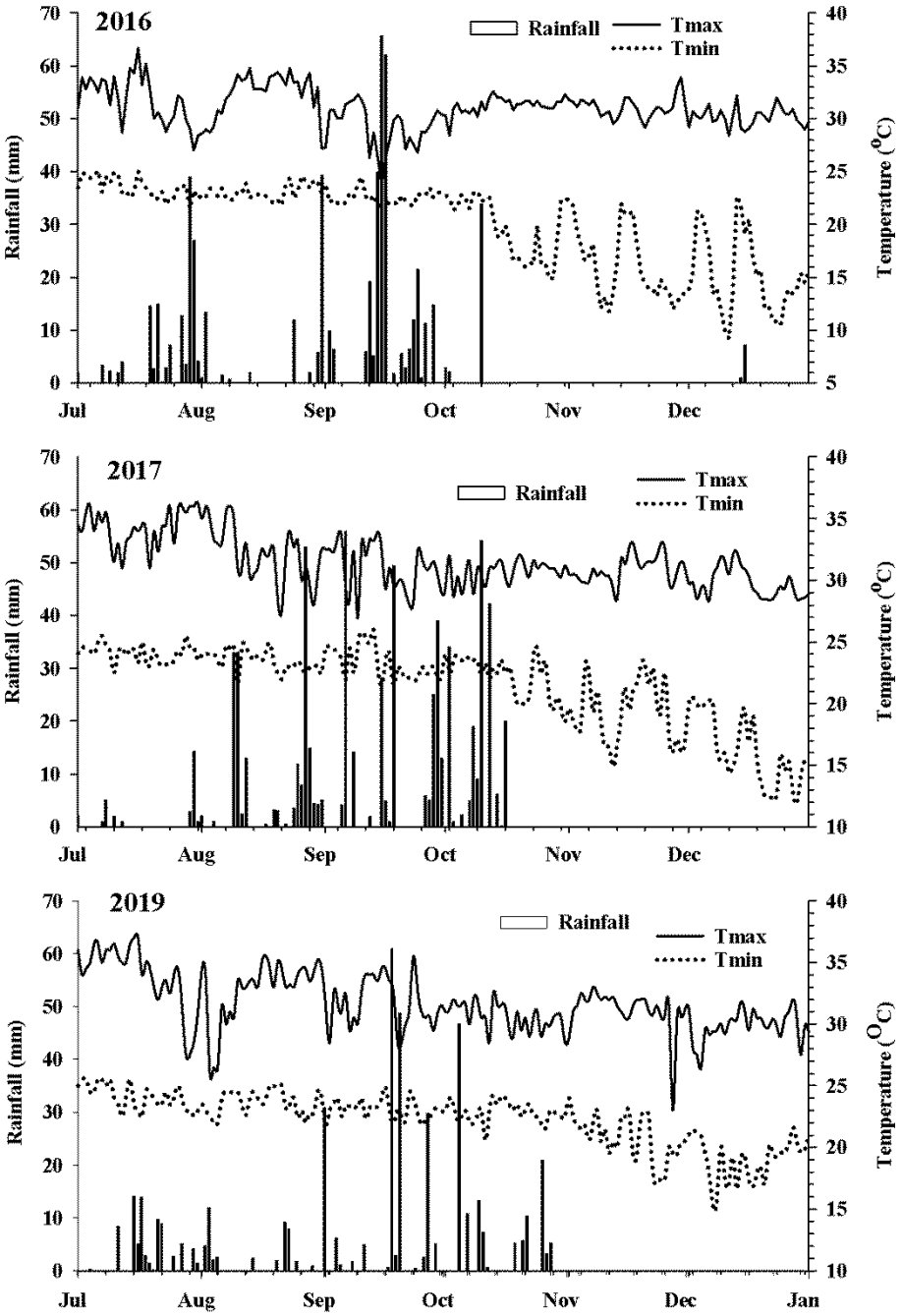

Fig. 1. Daily weather data of rainfall, maximum and minimum temperature recorded during cropping period (July- December) at experimental site

Table 1. Response of sunflower growth and yield attributes influenced by varying planting geometry and fertilizer levels under different land configurations under rainfed condition

Treatments	Plant height (cm)	Head diameter (cm)	100 seed weight (g)	Seed yield (kg ha-1)	Oil content (%)	Oil yield (kg ha-1)
Land configuration						
M_1: Flatbed sowing at 60 cm x 30 cm	179.9	14.8	5.60	1409	33.3	471.0
M_2: Ridges and furrow sowing at 60 x 30 cm	186.5	15.0	5.67	1856	33.9	628.7
M_3: Flat bed- paired row planting at 45 cm x 40 cm with 75 cm	184.5	14.7	5.89	1501	34.2	511.0
M_4: Broad bed and furrow - paired row planting at 45 cm x 40 cm	184.8	15.0	5.86	1663	33.5	557.9
S.Em.+	0.43	0.21	0.06	48	0.25	16.50
CD @ 5%	1.51	NS	0.19	171	NS	58.2
Fertilizer Levels						
F_1: 75% RDF	175.1	14.4	5.43	1410	33.58	474.2
F_2: 100% RDF	184.9	14.9	5.68	1639	33.93	556.1
F_3: 125% RDF	191.6	15.4	6.13	1772	33.70	596.3
S.Em.+	1.22	0.15	0.07	41	0.43	14.3
CD @ 5%	3.69	0.44	0.20	123	NS	43.2
Interaction (M x F)						
S.Em.+	0.74	0.36	0.10	83.9	0.43	28.6
CD @ 5%	NS	NS	NS	NS	NS	NS
S.Em.+	2.04	0.32	0.12	78.5	0.49	28.6
CD @ 5%	NS	NS	NS	NS	NS	NS

Table 2. Economic returns of sunflower to varying planting geometry and fertilizer levels under different land configurations under rainfed condition

(Average of three years)

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross Returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B C ratio
Land configuration				
M_1: Flatbed sowing at 60 cm x 30 cm	24438	49589	25151	2.01
M_2: Ridges and furrow sowing at 60 cm x 30 cm	25378	64191	38813	2.50
M_3: Flat bed- paired row planting at 45 cm x 40 cm with 75cm alley between pairs	24543	51874	27331	2.10
M_4: Broad bed and furrow - paired row planting at 45 cm x 40 cm	25376	57184	31808	2.23
S.Em.+	-	1936	1645	0.09
CD @ 5%	-	6830	5804	0.24
Fertilizer Levels				
F_1: 75% RDF	22626	49039	26413	2.15
F_2: 100% RDF	24990	56845	31855	2.25
F_3: 125% RDF	27184	61244	34060	2.22
S.Em.+	-	1302	1278	0.07
CD @ 5%	-	3937	3864	NS
Interaction (M X F)				
S.Em.+	-	3354	2850	0.15
CD @ 5%	-	NS	NS	NS

4. CONCLUSION

It is clear from the study that, the present study showed that planting sunflower seeds on the ridges and furrows at the recommended row spacing of 60 cm along with 25% higher than recommended dose of fertilizer gave greater net profit, the B C ratio. It can be recommended for sunflower production under limited water condition or rainfed ecosystems.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous. Indiastat, India-Area, yield and production for the year 2021-22; 2021.
   Availlable:https://www.indiastat.com
2. Let B, Bhanurekha K, Sudhakara Babu SN, Madhavi A. Resposne of sunflower to fertiliser levels under different planting geometry and land configurations. The Andhra Agric. J. 2016; 63(2):283-286.
3. Kaya, Mehmet Demir, Suay Bayramin, Gamze Kaya. The effect of planting geometry and seed priming on sunflower yield under rain-fed conditions. Fresen. Environ. Bull. 2015;24: 4095-4101.
4. Yasin M, Mahmood A, Iqbal Z. Growth and yield response of autumn planted hybrid sunflower (*Helianthus annuus* L.) to varying planting densities under subtropical conditions. Int. J. Agric. Appl. Sci. 2011;3(2):86-88.
5. Lopez Pereira M, Hall AJ. Sunflower oil yield responses to plant population and row spacing: Vegetative and reproductive plasticity. Field Crops Res. 2019;230:17-30.
6. Prabhakar K, Lakshmi Kalyani D, Sudhakara Babu SN, Neelima S, Venkata Ramanamma K, Subba Rao M. Response of rainfed sunflower (*Helianthus annuus* L.) to varying planting geometry and fertilizer levels under different land configurations in Vertisols. J. Oilseeds Res. 2019;36(1):45-50.
7. Saleem MF, Malik MA, Cheema MA, Wahid MA. Yield and quality response of autumn-planted sunflower (*Helianthus annuus* L.) to sowing dates and planting patterns. Canadian J. Plant Sci. 2008; 88:101-109.
8. Pavani S, Bhanu Rekha K, Sudhakara Babu SN, Padmaja G. Effect of nitrogen and sulphur on growth, yield and quality of sunflower (*Helianthus annuus* L.). Crop Res. 2013;45(1,2&3): 152-154.
9. Guled MB, Surkod VS, Kabadagi CB. Response of sunflower to moisture conservation practices and planting geometry. Int. J. Agril. Sci. 2010;6(2):389-391.
10. Sneha MA, Desai BK, Umesh MR, Koppalkar BG, Kuchanur PH. Effect of planting density and fertilizer rate on performance of newly developed sunflower hybrids (*Helianthus annuus* L.). The Pharma Innov. J. 2022;11(8):167-178.
11. Sardana V, Bajaj RK. Effect of intra row spacing and nitrogen application on the productivity of hybrid sunflower (*Helianthus annuus* L.) sown on varied dates. J. Oilseed Res. 2007;24(1):203-205.
12. Ali,A, Tanveer A, Nadeem MA, Tahir M, Hussain M. Effect of varying planting pattern on growth, achene yield and oil contents of sunflower (*Helianthus annuus* L.). Pakistan J. Agril. Sci. 2007;44:449-452.
13. Kadasiddappa MM, Shaik Mohammad, Rao PV. Effect of fertilizers on growth, yield and economics of sunflower (*Helianthus annuus* L.) J. Oilseeds Res. 2007; 24(1):200-202.
14. Malik MA, Shah SH, Mahmood Sultan, Cheema MA. Effect of various planting geometries on the growth, seed yield and oil content of new sunflower hybrid (SF-187). Int. J. Agric. Biol, 2001; 3(1):55-56.
15. Reddy BN, Sudhakara Babu SN, Bhanu Rekha K. Productivity and nutrient uptake of sunflower (*Helianthus annuus* L.) as influenced by site-specific integrated nutrient management on *Alfisols*. J. Oilseeds Res. 2007;24(2): 331-333.

16. Thorat DG, Abdul Hamid Giri MD, Mohammad Sajid, Katore JR. Effect of irrigation, phosphorus and sulphur on growth and yield attributes of rabi sunflower. Annals Plant Physio. 2007; 21(1):71-74.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/110303