Original Research Article

Planting geometry and nutrient management on productivity and quality of rainfed sunflower in *Vertisol*

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 byseeds planting on ridges and furrows at 60 cm x 30 cmoverflatbed 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 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 planting on ridges and furrows at 60 cm x 30 cm was found to enhance yield and economics than existing traditional flatbed sowing at 60 cm x 30m spacing. Further, sunflower yield improvement was also observed by application of graded fertilizers of 25% higher than existing recommendations.

Key words: Land configuration Planting geometry, Sunflower, Broadbed and furrow, Paired row, *Vertisol*

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Introduction :

The sunflower (*Helianthus annuus* L.) is one of the most economically important edible oil-producing crops in the world. It is highly promising for around-the-year cultivation underdifferent 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 (Anon., 2021). It is very low 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 (Let*et al.,* 2016). There is ample scope of increasing production by use of good agronomic practices (GAP) as well as proper fertility management (Kaya *et al.*, 2015; Choudhary *et al.,* 2013).

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 (Yasin *et al.,* 2011). *C*onventionally, the sunflower crop is grown on flat planting without taking care of its planting time under rainfed.Apart from planting time, method and row spacing play vital role in improving sunflower productivity. Sunflower response to row plasticity was also demonstrated by Lopez Pereira and Hall (2019). 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 (Prabhakar *et al.*, 2019; Saleem *et al.*, 2008). The objective of this field study was to determine the impact of land configurations, sowing method along with fertilizer rate on seed yield, oil contentand economics of rainfed sunflower in *Vertisol*.

MATERIALS AND METHODS

A field experiment was conducted at Main Agricultural Research Station, Raichur, University of Agricultural Sciences, Raichur (16°12' N 77° 19'3 E, 407 m elevation) Experiment was conductedunder 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) and available K_2O (536 kg/ha). The experiment was laid out in a split plot design replicated thrice. 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, 100 % RDF (90:90:60 N, P_2O_5 and K_2O kg/ha) and 125% RDF. Sunflower hybrid RSFH-1887 was sown in 2nd week of July and harvested at 4th Week of October in all the years of study.As per treatments 90 kg P_2O_5 and 60 kg K_2O along with 45 kgN were applied atsowing. The rest of the45 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. Intercultivation was done at 30 DAS for further weed control. Throughout the cropping period no irrigation water was provided. ~~Need based plant protection measures were taken~~. Different growth parameters of sunflower were differed significantly due to land configuration and fertilizer levels in *Vertisols* at Raichur.Economics of the study was worked out by considering prevailed market grain price during study year. Data collected were

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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.

Results and Discussion

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. 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 (Fig. 1). Temperatures in the region are generally higher fromMarch to June.

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) 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) 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) as compared to present practice of flatbed sowing (471 kg/ha). Further significant improvement in sunflower oil yield was observed by fertilizer application at 125% RDF (596.3 kg/ha) over 100% and 75% RDF (Table 1). Pavani et al. (2013) 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. (2010) also realized the ridges and a furrow was best way to conserve moisture in rainfed sunflower. At same experimental site, Sneha et al. (2022) also showed significant effect of planting density on yield traits, seed and yield of sunflower. Results of other trials reported by Prabhakar*et al*. (2019), Let *et al*. (2016) showed increased sunflower yield attributes by higher rate of fertilizers.

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 returns 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. (2019); Let et al. (2016); Sardana and Bajaj (2007).

Conclusion

It is clear from the study that, planting sunflower seeds on the ridges and furrows at the recommended row spacing of 0.6m 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.

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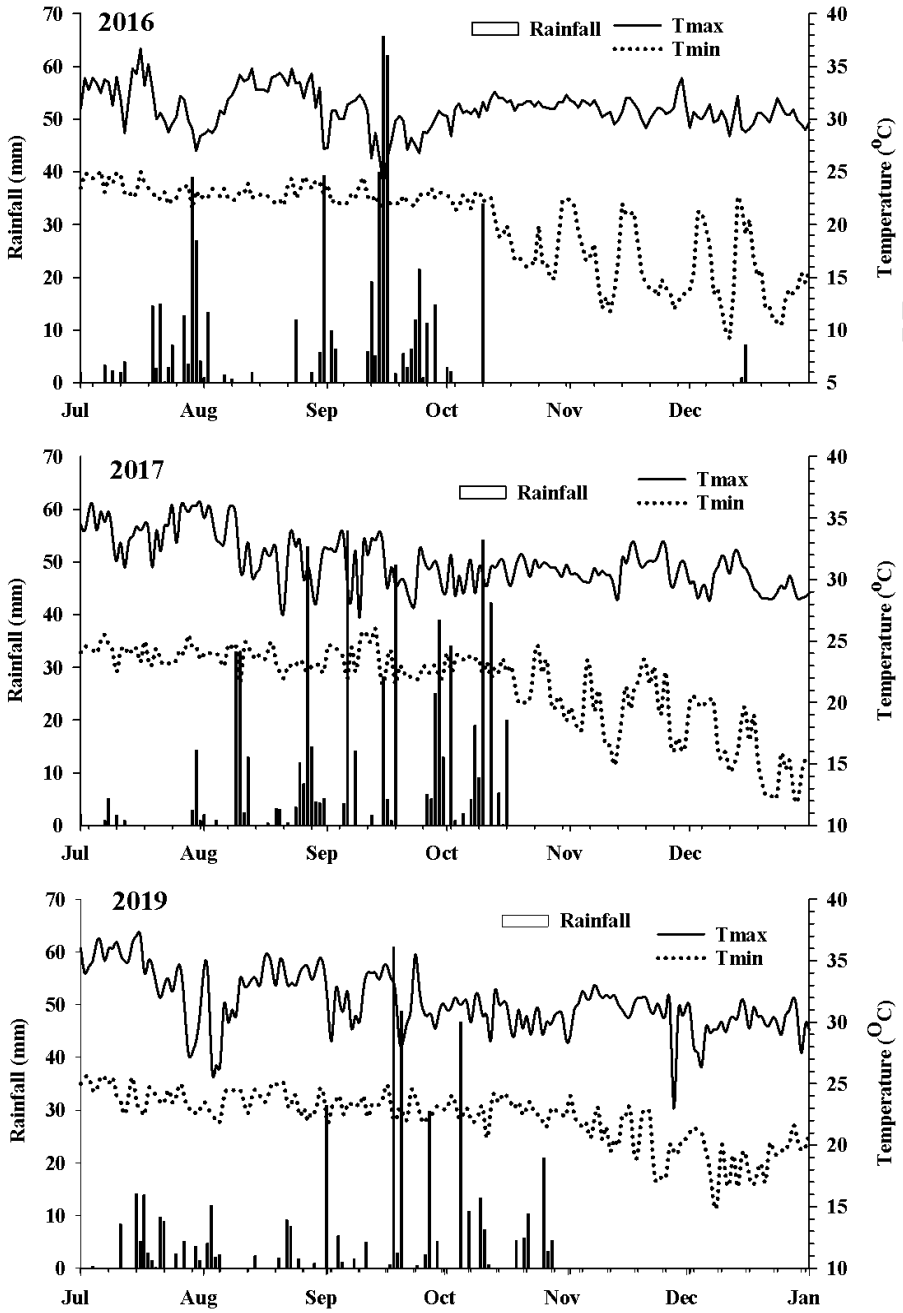

Fig 1: Daily weather data of rainfall, maximum and minimum temperature recorded during cropping period (July- December) at experimental site.

Table 1: Response of sunflower seed yield (kg/ha) to varying planting geometry and fertilizerlevels under different land configurations under rainfed condition

Treatments	Plant height (cm)	Head diameter (cm)	100 seed weight (g)	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)
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 60x 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 75cm	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 (Rs./ha) 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)	Gross Returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Land configuration				
M1: Flatbed sowing at 60 cm x 30 cm	24438	49589	25151	2.01
M2: Ridges and furrow sowing at 60 cm x 30 cm	25378	64191	38813	2.50
M3: Flat bed- paired row planting at 45 cm x 40 cm with 75cm alley between pairs	24543	51874	27331	2.10
M4: 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				
F1: 75% RDF	22626	49039	26413	2.15
F2: 100% RDF	24990	56845	31855	2.25
F3: 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