The Pharma Innovation Journal 2022; 11(12): 5901-5905

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 5901-5905

www.thepharmajournal.com
Received: 03-09-2022
Accepted: 11-10-2022

PS Uttarwar
PG Scholar, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

AB Chorey
Associate Professor, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
PS Uttarwar
PG Scholar, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Response of sunflower (*Helianthus annuus* L.) to different land configurations and fertilizer levels in *kharif*

PS Uttarwar and AB Chorey

Abstract
An agronomic investigation was carried out on sunflower hybrid DRSH-1 at oilseed research unit farm, Dr. PDKV, Akola during *Kharif* season of 2014 to study the influence of different land configurations and fertilizer levels on quality, yield and economics of sunflower. Land configuration of ridges and furrow recorded significantly higher oil content (%), seed yield ha^{-1} and oil yield ha^{-1} and economics. Application of 125 percent RDF (100:75:37.5 NPK kg ha^{-1}) recorded higher oil content (%), seed yield ha^{-1} and oil yield ha^{-1} and economics.

Keywords: Sunflower, fertilizer levels, land configurations, ridges and furrow, oil content

Introduction
Sunflower is one of the important edible oilseed crops cultivated in different parts of the world and has become the fourth most important oilseed crop in India. Presently, in India sunflower is grown over an area of 6.91 lakh hectares with a production of about 5.46 lakh tonnes and with average productivity of 791 kg ha^{-1} (Anonymous 2014) [3]. Poor soil management is one of the major factors responsible for low productivity of crops. Therefore, land configuration treatments has certain effect on soil moisture status, due to conservation of soil moisture and increasing water holding capacity which might help for availability of water and nutrients to crop and helps to boost up the overall production.
Fertilizer is costly but important input in crop productivity. Its proper management not only improves the efficiency of applied nutrients but also reduces the gap between addition and removal of nutrients. As such information on a suitable land configuration with fertilizer levels in sunflower is useful for exploiting its full potentiality to boost up the yield level under rain fed conditions. In the proposed study the attempt has been made to optimize productivity of sunflower in Vidarbha.

Materials and Methods
An agronomic investigation was carried out on sunflower hybrid DRSH-1 at Oilseed research unit farm, Dr. PDKV, Akola during *kharif* season of 2014.The soil of experimental field was clayey having pH 8.1. It was low in available nitrogen (210.5 kg ha^{-1}), low in available phosphorus (15.20 kg ha^{-1}) and high in available potassium (354.33 kg ha^{-1}).The treatments comprising two land configurations *viz*., ridges and furrows and flat bed and three fertilizer levels *viz*., 75 percent RDF, 100 percent RDF (80.60.30 N, P_2O_5, K_2O kg ha^{-1}) and 125 percent RDF, were laid out in Factorial Randomized Block design with four replications. Sowing was done at spacing of 60×30 cm. Fertilizers were applied as per treatment combinations. A half dose of N and full dose of P and K were applied at the time of sowing and the remaining half dose of N was applied in the rows at 30 days after sowing. The rainfall of 235 mm was received during crop season in 14 rainy days. Data on quality, yield economics were recorded at harvest. Some of the important findings emerged from this investigation are summarizes as below.

Results and Discussion

Table 1: Number of seed per plant^{-1}, Seed yield plant^{-1} (g) and 100 seed weight (g) of sunflower as influenced by different treatments

Treatment	No. of seed plant^{-1}	Seed yield plant^{-1} (g)	100 seed weight (g)
Land configuration			
M_1-Flat bed	702.17	39.71	4.98
M_2-Ridges and furrows	749.58	43.33	5.03
SE(m)±	9.20	1.07	0.43
CD at 5%	27.73	3.23	NS
Fertilizer levels			
F_1-75% RDF	672.38	36.33	4.79
F_2-100% RDF	737.50	43.63	5.06
F_3-125% RDF	767.75	44.61	5.16
SE(m)±	11.27	1.31	0.52
CD at 5%	33.96	3.95	NS
Interaction A x B			
SE(m)±	15.93	1.85	0.74
CD at 5%	NS	NS	NS
GM	725.87	41.52	5.00

Number of seeds plant^{-1}

More number of seeds plant^{-1} directly influenced the yield of crop. Data in respect of number of seeds plant^{-1} as influenced by different treatments are presented in Table 19. The mean number of seeds plant^{-1} was 725.87.

Effect of land configuration

The number of seeds plant^{-1} were significantly increased with land configuration. The maximum number of seeds per plant (749.58) was recorded with ridges and furrow, which was significantly superior over flatbed (702.17). About 6.32 percent increase was observed with ridges and furrow than flat bed. Higher number of seeds per plant could be attributed to adequate availability of soil moisture under ridges and furrow system over flat bed. These results agree with the view of Akhtar *et al*., (1993) [2] who reported significant differences in number of seeds per plant in sunflower sown on ridges.

Effect of fertilizer level

Fertilizer levels significantly influenced the number of seeds per plant. Application of 125 percent RDF (767.75) recorded maximum number of seeds per plant which was significantly superior over 75 percent RDF (672.38) and at par with 100 percent RDF (737.50).About 12.03 percent more number of seeds plant^{-1} was recorded with 125 percent RDF as compared to 75 percent RDF.

More number of seeds per plant with application of 125 percent RDF is the result of maximum head diameter in this treatment. Similar results were obtained by Rao and Saran (1981), Hegde and Havangi (1987) [6] and Raj *et al*. (1999) [13].

Interaction effect

None of the interaction was found to be significant for number of seeds per plant of sunflower.

Seed yield plant^{-1} (g)

Data in respect of seed yield per plant (g) as influenced by different treatments are presented in Table 1. The mean seed yield plant^{-1} was 41.52 g.

Effect of land configuration

Land configuration had significant influence on seed yield per plant. Ridges and furrow (43.33 g) recorded significantly higher seed yield plant^{-1} which was superior over flatbed (39.71g). About 8.35 percent more seed yield plant^{-1} was recorded in ridges and furrow as compared to flat bed.

Significant increase in number of seed plant^{-1} resulted in highest seed yield plant^{-1} in this treatment. Increase in seed yield plant $^{-1}$ with ridges and furrow over flatbed method was also reported by Ingle *et al*. (1999) [4].

Effect of fertilizer level

Sunflower seed yield plant^{-1} significantly increased with successive increasing level of fertilizer. The highest seed yield plant^{-1} was recorded with application of 125 percent RDF (44.61 g) which was significantly superior over 75 percent RDF (36.33 g) and at par with 100 percent RDF (43.63 g).125 percent RDF recorded 18.56 percent more yield plant^{-1} as compared to 75 percent RDF.

Maximum seed yield plant^{-1} with application of 125 percent RDF (44.61g) is due to maximum head diameter, more number of seed plant^{-1} and the highest test weight in this treatment. This finding is in close proximity with that of Sabale (2003) [11] and Shivamurugan *et al*. (2003) in sunflower.

Interaction effect

None of the interaction was found to be significant for seed yield plant^{-1} of sunflower.

100 seed weight (g)

The 100 seed weight expresses the magnitude of seed development which is an important determinant of seed yield and seed quality. Data in respect of 100 seed weight as influenced by different treatments are presented in Table 19. The mean 100 seed weight was 5.00 g.

Effect of land configuration

The 100 seed weight was found to be non-significant by land configuration. However, ridges and furrow (5.03 g) recorded numerically maximum 100 seed weight as compared to flatbed (4.98 g).

Effect of fertilizer level

There was no significant effect found for 100 seed weight by different fertilizer levels. However, 125 percent RDF (5.16 g) recorded numerically maximum 100 seed weight followed by 100 percent RDF (5.06 g) and lowest 100 seed weight recorded with 75 percent RDF (4.79 g).

Interaction effect

No treatment combination had significantly influenced on 100 seed weight

Table 2: Oil content (%), oil yield (kg/ha) economics of sunflower cultivation

Treatment	Seed yield/ ha (kg/ha)	Oil content (%)	Oil yield (kg/ha)	GMR (Rs./ ha)	NMR (Rs./ ha)	B:C Ratio
A. Land configuration						
M_1 - Flat bed	814.16	37.73	306.89	27819	11715	1.72
M_2 - Ridges and furrows	926.49	38.94	374.07	31498	14394	1.84
SE(m)±	17.56	1.11	12.05	588.75	588.75	-
CD at 5%	52.94	NS	36.33	1774.67	1774.67	-
B. Fertilizer levels						
F_1 - 75% RDF	702.44	38.73	250.29	24200	8814	1.57
F_2 - 100% RDF	916.89	38.52	370.67	31214	14605	1.87
F_3 - 125% RDF	991.63	37.75	400.49	33562	15744	1.88
SE (m)±	21.51	1.36	14.76	721.06	721.06	-
CD at 5%	64.83	NS	44.49	2173.52	2173.52	-
C. Interaction A x B						
SE(m)±	30.42	1.93	20.87	1019.74	1019.74	-
CD at 5%	91.69	NS	NS	NS	NS	-

Seed yield (kg ha^{-1})

Data regarding seed yield (kg ha^{-1}) as influenced by different treatments are presented in Table 20 and graphically depicted Fig. 8. The mean seed yield was 870.32 kg ha^{-1}.

Effect of land configuration

Final seed yield is the function of combined effect of all the yield components under the influence of a particular set of environmental conditions. As regards land configuration, ridges and furrow recorded highest seed yield (926.49 kg ha^{-1}) which was found to be significantly superior over flatbed (814.165 kg ha^{-1}). Yield of sunflower over flatbed was 12.12 percent more when sunflower sown with ridges and furrow. The percent difference in seed yield was lesser as the rainfall during this season was quiet low during all the growth stages of sunflower crop. (Rainfall at vegetative stage was 211.8 mm and at reproductive stage *viz.*, flowering stage, seed filling stage upto harvest it was 23.2 mm). Maintenance of favourable moisture (31.29 percent) at the time of seed filling stage by supplying irrigation, aeration and more uptake of nutrients like N (37.70 kg ha^{-1}), P (15.35 kg ha^{-1}) and K (87.24 kg ha^{-1}) was the principle reason for better performance under this treatment.

Similar type of results were reported by Malik *et al*., (2001) [7] also present a similar results and found that the highest yield was obtained from the crop on ridges.

Effect of fertilizer level

Seed yield was significantly influenced by fertilizer application. It was increased significantly with increasing levels of fertilizer from 75 percent RDF to 125 percent RDF. 125 percent RDF recorded the highest seed yield (991.63 kg) of sunflower which was significantly superior over 75 percent RDF (702.44 kg) and 100 percent RDF (916.89 kg). Application of 125 percent RDF recorded increased seed yield ha^{-1} by 29.1 percent as compared to 75 percent RDF and 7.53 percent as compared to 100 percent RDF.

This might be due to maximum yield per plant with average plant population, maximum head diameter, more number of seed per plant and highest test weight due to higher levels of fertilizer. Similar yield increase with higher fertility level were quoted by Rao and Saran (1991), Singh *et al*. (1998), Devidayal and Agrawal (1998), Singh *et al*. (1999), Nandhagopal *et al*. (2003), Sable (2003) and Ozer *et al.* (2004) [16], Ashok Kumar *et al.* (2013).

Interaction effect

The interaction between land configuration and fertilizer level on seed yield (kg ha^{-1}) was found to be significant. Perusal of data (Table 20a) indicates that, ridges and furrow with 125 percent RDF recorded significantly highest seed yield which was found at par with ridges and furrow with 100 percent RDF. Significantly lower seed yield noted with flat bed with 75 percent RDF.

Table 2(a): Seed yield (kg ha^{-1}) of sunflower as influenced by land configuration × Fertilizer level interaction at harvest

M/F	F_1	F^2	F_3	Mean
M_1	621.29	838.04	983.14	814.16
M_2	783.60	995.75	1000.13	926.49
Mean	702.4450	916.8947	991.63	870.32
SE(m)±	30.42			
CD at 5%	91.69			

The superior yield performance of treatment combination ridges and furrow with 125 percent RDF could be attributed to enhanced growth in terms of plant height, larger head size having more seed head^{-1} and higher test weight. This might be due to a more efficient utilization of moisture from deeper layers during dry spells in addition to the availability of adequate nutrients in the root zone. Favourable response of sunflower hybrids to fertilization in the presence of adequate moisture has been observed by Megur *et al.* (1993) and Devidayal and Agarwal (1998). Increased seed yield of sunflower planted on ridges than flatbed sowing has also been reported by Hussain (1994) [5].

Straw yield (kg ha^{-1}): Data regarding straw yield (kg ha^{-1}) as influenced by different treatments is presented in Table 20. The mean straw yield was 3551.37 kg ha^{-1}.

Effect of land configuration

Straw yield was significantly influenced by land configuration treatments. It was significantly maximum in treatment ridges and furrow (3401.75 kg ha^{-1}) over flat bed. (3701 kg ha^{-1}). Ridges and furrow increased straw yield by 8.08 percent as compared to flat bed. The increase in straw yield due to ridges and furrow may be attributed to better vegetative growth as observed through more plant height, number of leaves per plant and dry matter accumulation per plant. This result is in close proximity with the findings of Ingle *et al*. (1999) [4].

Effect of fertilizer level

Fertilizer application significantly increased straw yield. The highest straw yield of 3874.88 kg ha^{-1} was recorded with the application of 125 percent RDF which was significantly superior over 75 percent RDF (3073.63 kg ha^{-1}) and at par with 100 percent RDF (3705.63 kg ha^{-1}). About 20.67 percent increase was observed with application of 125 percent RDF as compared to 75 percent RDF.

The higher straw yield with application of 125 percent RDF is attributed to maximum head diameter, dry matter accumulation per plant and more uptake of nutrients (N, P and K) in this treatment. Present result is in the line of findings made by Rao and Saran (1991), Singh *et al*. (1998) and Nandhagopal *et al*. (2003).

Oil content (%)

Data regarding oil content (%) as influenced by different treatments is presented in Table 20.

Effect of land configuration

There were no significant difference found in oil content (%) due to land configuration, however maximum oil content (38.94%) was observed due to ridges and furrows which was highest over flatbed (37.73%). The increase in oil content (%) due to ridges and furrow was 3.1 percent as compared to flat bed.

Comparable results were reported by Nazir *et al*. (1991) that seed oil content (%) was not affected significantly by any of the planting patterns, in spring and autumn. Contradictory results were obtained by Ahmad *et al*. (2000) [1] who observed that increase in oil content up to 42.50% was recorded when the crop was sown on ridges. These results are in line with those of Hussain *et al*. (1980) and Malik *et al*. (2001) [7].

Effect of fertilizer level

Effect of fertilizer level was found to be non-significant for oil content (%), however 75 percent RDF recorded 2.53 percent maximum oil content (38.73%) followed by 100 percent RDF (38.52%) and lowest oil content was recorded by 125 percent RDF (37.75%). Indicating that oil content (%) had inverse relationship to increase in fertilizer level. This might be due to fact that the fertilizer nitrogen caused comparatively greater accumulation of protein in seeds thereby hindering a satisfactory availability of carbohydrates for polymerization into fatty acids, which has lowered the content of oil in seed. (Nawaz *et al*., 2003) [8]. Similar result were reported by Sharma and Gaur (1988) [10] and Legha and Giri (1999) [9].

Interaction effect

Interaction was found to be non-significant.

Oil yield (kg ha^{-1})

Data regarding oil yield (kg ha^{-1}) as influenced by different treatments is presented in Table 20. The mean oil yield was 340 kg ha^{-1}.

Effect of land configuration

Oil yield (kg ha^{-1}) was significantly affected by land configuration. Maximum oil yield was obtained under ridges and furrow (374.07 kg ha^{-1}) as compared to flatbed (306.89 kg ha^{-1}). The possible reason may be that ridge sowing provided soft or loosened soil and favourable environment to the plants. Conformatory results were given by Fsechie *et al*. (2000) [17] who reported that oil yields were higher under ridge sown sunflower over flat bed.

Effect of fertilizer level

Oil yield increases linearly with increase in fertilizer levels from 75 percent RDF to 125 percent RDF. Highest oil yield was recorded with application of 125 percent RDF (400.49 kg ha^{-1}) which is significantly superior over 75 percent RDF (250.29 kg ha^{-1}) and at par with 100 percent RDF (370.67 kg ha^{-1}). The increase in oil yield was about 37.50 percent more in 125 percent RDF as compared to 75 percent RDF.

Highest oil yield due to 125 percent RDF is attributed to highest seed yield in this treatment. Similar results were reported by Sharma and Guar (1988) [10], Legha and Giri (1999) [9], Jat and Giri (2000) [15] and Ozer *et al*. (2004) [16].

Interaction effect

The interaction between land configuration and fertilizer level was found to be non-significant for oil yield.

Economic studies

Data regarding gross monetary returns (GMR), net monetary returns (NMR) and B: C ratio as influenced by different treatments are presented in Table 21.

Effect of land configuration

It could be seen from the table that land configuration had significant influenced on gross monetary returns, net monetary returns and B: C ratio. Highest gross monetary returns (` 31498.84 ha$^{-1}$), net monetary returns (` 14394.72 ha^{-1}) and B: C ratio (1.84) were obtained in ridges and furrow over flat bed. These findings are in close accordance with Meharsingh *et al*. (1986) reported that maximum GMR, NMR and B: C ratio were recorded under ridges and furrows method of planting in soybean which was more than flat bed. Similar results were also reported by Somasundaram *et al*. (2000), Pendke *et al*. (2004) and Patil (2005).

Effect of fertilizer level

Application of fertilizer had significantly influenced on gross monetary returns, net monetary returns and B: C ratio.

The data from Table 21 shows that, highest gross monetary returns of (` 33562.89 ha$^{-1}$), net monetary returns (` 15744.64 ha^{-1}) and B: C ratio (1.88) were obtained by treatment 125 percent RDF, which was significantly superior over 75 percent RDF (` 24200.10 ha$^{-1}$, 8814.47 ha$^{-1}$ and 1.57, respectively) and at par with 100 percent RDF (` 31214.47 ha^{-1}, 14605.97 ha^{-1}, 1.87, respectively).

Highest gross monetary returns, net monetary returns and B:C ratio with application of 125 percent RDF due to the fact that, this treatment recorded highest seed yield ha^{-1}.

Interaction effect

The interaction effect between land configuration and fertilizer levels on gross monetary returns and net monetary returns were found to be non-significant

Conclusion

The following conclusions could be drawn from the present investigations

1. Ridges and furrow significantly increased growth, yield attributes, yield of sunflower and B: C ratio and found

most economical as compared to flatbed sowing.
2. Application of 125 percent RDF proved beneficial in enhancing growth, yield attributes, yield of sunflower and B: C ratio followed by 100 percent RDF.
3. Ridges and furrow with 125 percent RDF recorded highest seed yield of sunflower followed by ridges and furrow with 100 percent RDF.

Acknowledgement
Inspiration is the best medicine which can make it possible to run for crippled one and it is veritable gold of mine to get the talented and inspiring wilful guidance of Dr, A.B. Chorey Assistant Proffesor, *Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.)*Department of Agronomy, Akola, who in this unique way, provided me with constant encouragement inspiring, scholastic guidance, love and affection offered to me during the course of my study and research works would be a poor vehicles to communicate her my sense of gratitude.

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