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Growth attributes, yield and soil moisture studies of linseed as influenced by different land configuration treatments and irrigation levels

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Abstract
An investigation was undertaken at College of Agriculture, Nagpur to study the effect of land configuration and irrigation levels on growth, yield attributes and yield of linseed during *rabi* season of 2014-2015 in split plot design with twelve treatment combinations consisting of four land configurations viz., L_1 (Flat bed), L_2 (Ridges and furrow), L_3 (Opening of furrow after two rows) and L_4 (Broad bed furrow) and three irrigation levels viz., I_{1-} One irrigation at flowering (40-45 DAS), I_{2-} Two irrigations, one at flowering (40-45 DAS) and second at capsule formation (65-70 DAS) and I_{3-} Three irrigations, one at vegetative (20-25 DAS), second at flowering (40- 45 DAS) and third at capsule formation (65-70 DAS) replicated three times. Linseed variety PKV NL-260 was used as a test crop. The soil was clayey in texture with p^H 7.8 indicating slightly alkaline in reaction. Results showed that application of land configuration treatments significantly increased plant height, number of branches, dry matter accumulation plant^{-1} (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and oil content (kg ha^{-1}). Highest values of all the growth characters were recorded in land configuration treatment of broad bed furrow (BBF) but at par with treatment of ridge and furrow. Also seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and oil yield (kg ha^{-1}) had higher values with BBF but at par with ridge and furrow. Results further revealed that application of three irrigations, one at vegetative stage, second at flowering and third at capsule formation recorded significantly higher values of growth parameters, seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and oil yield (kg ha^{-1}) over treatment of one irrigation at flowering and was at par with two irrigations, one at flowering and second at capsule formation.. Higher moisture content was noticed in treatment of broad bed furrow (L_4) among various land configuration treatments. The BBF recorded minimum consumptive use (105.68 mm). The higher water use efficiency was recorded by BBF (13.21 kg ha mm^{-1}) followed by ridges and furrow (11.97 kg ha mm^{-1}). The highest water use efficiency of (16.28 kg ha mm^{-1}) was recorded in treatment (I_3). Consumptive use increased to 175.73 mm when three irrigations were given one at vegetative stage, second at flowering and third at capsule formation.
Interaction effect of land configuration and irrigation levels were found to be non significant in respect of all yield parameters seed and oil yield.

Keywords: Yield, land configuration, irrigation levels, yield attributes

Introduction

Linseed (*Linum usitatissimum* L.) is an important oilseed crop of central India, locally known as jawas or alsi. It has been grown from ancient time for flax (fiber) and for seed purpose which is rich in oil. Linseed contains high level of lignan and Omega-3 fatty acid possesses anti cancer properties and studies found reduced growth in specific types of tumors. Initial studies suggest benefit individual with certain types of breast and prostate cancer. Linseed is unique among oilseeds as it has high content of Omega-3 fatty acid, alpha linolenic acid (ALA). Linseed contains 35 to 45% oil with ALA making up about 57% of the total fatty acids. Omega-3 fatty acids lower levels of triglycerides in blood, thereby reducing heart disease, and also shows promising battle against inflammatory diseases such as rheumatoid arthritis. Linolenic acid (LA), an Omega-6 essential fatty acid is also found in linseed. In India it is grown over an area 468.0 thousand ha which produce about 1.41 lakh tonnes and its cultivation is mostly confined to Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar and West Bengal. Madhya Pradesh rank first in both area and production among linseed growing states of India. Since, area under linseed is decreased now a day due to less yield hence production technology suitable to its high production needs to be perfected. Increase in crop production can be realized by either extending total area under this crop or by enhancing crop productivity. To ensure high crop productivity, adoption of improved agronomic techniques is essential. Most of the studies indicate that increase in yield is mainly associated with land configuration and irrigation management method. Resorting sowing on land configuration like broad bed and furrow (BBF), ridges and furrow and provision of furrow at regular intervals and reduced tillage are known to help linseed crop during water stress. The proper land configuration is known for increasing moisture intake and resultant yield. The broad bed and furrow acts as drains in high rainfall region and also help in providing more opportunity for in situ soil water conservation. Nalawade and More (1993) reported that, BBF give more pod yield than furrow in every row, furrow after two rows and flat beds. The BBF, NBF, furrow after two rows gave pod yield of 1.33, 1.25, 1.11 t ha^{-1}, respectively. Excess irrigation causes water logging condition because heavy soils of Vidarbha are poor in drainage. This ultimately affects crop growth and further crop yield. Hence judicious uses of irrigation water become prime importance. Ram Pyare *et al*. (2005) [10] reported that irrigation at flowering and capsule formation stage enhances grain yield to 4.33 q ha^{-1} than no irrigation. Therefore, timely irrigation is most important to get high yield from linseed crop. Yenpreddiwar *et al*. (2007) [14] reported that, irrigation at flowering and capsule filling stages recorded highest yield of 1182 kg ha^{-1} than irrigation at flowering stage and no irrigation. Deep black cotton soil having high water holding capacity and stickiness in Nagpur region of Maharashtra state limit the linseed cultivation due to poor drainage. To protect the crop from this hazard and to provide better soil condition for healthy, luxurious proliferation of roots and good response to fertilizer application suitable the present investigation was planned to find out an efficient land configuration method and an optimum irrigation level at which linseed gives maximum growth and seed yield.

Material and Methods

A field experiment was conducted at Agronomy farm, College of Agriculture, Nagpur during *rabi* season of 2014-2015 in split plot design with twelve treatment combinations consisting of four land configurations viz., L_1 (Flat bed), L_2 (Ridges and furrow), L_3 (Opening of furrow after two rows) and L_4 (Broad bed furrow) as main plot treatments and three irrigation levels viz., I_{1-} One irrigation at flowering (40-45 DAS), I_{2-} Two irrigations, one at flowering (40-45 DAS) and second at capsule formation (65-70 DAS) and I_{3-} Three irrigations, one at vegetative (20-25 DAS), second at flowering (40- 45 DAS) and third at capsule formation (65-70 DAS) as sub plot treatments replicated three times. The soil of experimental plot was medium in available nitrogen (208.94 kg ha^{-1}), low in available phosphorus (17.14 kg ha^{-1}), medium in organic carbon (0.57 %) and very high in available potash (350.42 kg ha^{-1}) as regards to fertility status and slightly alkaline in reaction (pH 7.8). The soil of the experimental field was clayey in texture. The crop variety PKV NL-260 was used with row to row spacing of 45 cm. Gross plot size was 4.05 m × 4.2 m and net plot size was 3.15 m × 3.8 m. The distance between two replications was 1.50 m and 1 m between two plots. Full dose of phosphorus and half dose of nitrogen were applied at sowing and remaining half dose of N was applied at 30 DAS.

The moisture percentage was calculated on oven dry basis by using following formula.

$$Pw = \frac{Ws_1 - Ws_2}{Ws_2} \times 100$$

Where,
Pw = Moisture percentage on oven dry basis
Ws_1 = Fresh weight of soil
Ws_2 = Dry weight of soil

Consumptive use of water under each irrigation treatment was calculated by considering following components.

1. The potential evapo-transpiration during the period of 72 hours after each irrigation.
2. Soil moisture depletion by crop from 0-30 cm depth of soil profile during period between two irrigations.
3. Effective rainfall during the interval between irrigations.

Consumptive use was estimated by use of following formula

$$Cu = \sum_{K=1}^{N} EK \, x \, 0.08 + \sum_{i=1}^{n} \frac{(Mai - Mbi)}{100} x \, Asi \, x \, Di + ER$$

Where,
Cu = Consumptive use of water in mm
EK = Actual evaporation for the period of 72 hours immediately after K^{th} irrigation from USWB class A open pan evapometer.
0.8 = Crop coefficient
N = Number of times
Mai = Soil moisture after irrigation in per cent
Mbi = Soil moisture before irrigation in per cent
N = Number of soil layers
Asi = Bulk density of the i^{th} layer (gm/cm^3)
Di = Soil depth of the i^{th} layer (mm)
Σ = Summation of
ER = Effective rainfall

As the water table was more than seven meters, ground water contribution was not taken into account.

Thus consumptive use during the given irrigation interval was worked out by adding all the above components together and all such consumptive use figures were added together to get the total consumptive use during the season of the crop.

Water use efficiency was calculated in different treatments on the basis of seed yield and consumptive use of water in a given treatment. It is the amount of seed yield per unit of consumptive use. The formula for water use efficiency is follows.

$$WUE = \frac{Y}{ET}$$

Where,
WUE = Water use efficiency in kg ha mm-1
Y = Economic yield in kg/ ha
ET = Total evapo-transpiration in mm

At the time of harvesting, Plant height (cm), No. of branches $plant^{-1}$, Dry matter $plant^{-1}$ (g), seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), Oil yield (q ha^{-1}), moisture content (%) at 0-30 cm depth, Consumptive use (mm) and Water use efficiency (kg ha mm^{-1}) were recorded. In order to represent the plot, five plants of linseed from each net plot were selected randomly for various biometric observations on post harvest studies.

The selected five plants were labeled and all biometric observations were recorded properly on them.

Results and Discussion

Effect on growth attributes

The data pertaining to plant height (cm), No. of branches plant^{-1} and Dry matter plant^{-1} (g) as influenced by various treatments are presented in Table 1.

Effect of Land configuration

The data revealed that, plant height (cm), No. of branches plant^{-1} and Dry matter plant^{-1} (g) were significantly maximum in BBF over flat bed but it was at par with ridges and furrow at all growth stages. Significant increase in these attributes with broad bed furrow and ridges and furrow indicated adequate moisture conservation in soil, which had been benefited to the crop during growth period, resulted in optimum cell division and their elongation which enhanced plant height.

These results are in confirmity with the findings of Patil *et al.* (2011) [7], Vaghasia *et al*. (2007) [12] and Lakhera (2008) [6].

Irrigation levels

Irrigation levels had significant influence on plant height (cm), No. of branches plant^{-1} and Dry matter plant^{-1} (g) at all stages of crop growth. The plant height, No. of branches plant^{-1} and Dry matter plant^{-1} (g) were significantly more in I_3- three irrigations, one at vegetative stage, second at flowering and third at capsule formation over flat bed but it was at par with I_2- two irrigations, one at flowering and second at capsule formation at harvest. Similar results were reported by Yenpreddiwar (2006) [13], Chauhan *et al.* (2008) [2] and Ram-Pyare *et al.* (2005) [10].

Interaction

Interaction effects of land configuration and irrigation levels were non-significant.

Effect on seed and oil yield

Data regarding mean seed yield (q ha^{-1}), straw yield (q ha^{-1}) and oil yield (q ha^{-1}) as influenced by different treatments are presented in table 1.

Effect of Land configuration

Seed yield ha^{-1}, straw yield (q ha^{-1}) and oil yield (q ha^{-1}) were significantly influenced due to various land configuration treatments. The land configuration treatment of BBF being at par with ridges and furrows showed significant increase in seed yield (q ha^{-1}), straw yield (q ha^{-1}) and oil yield (q ha^{-1}) over flat bed and furrow after two rows. It is a well known fact that, land configuration treatments helps in moisture conservation and providing good drainages which might be the reasons in producing more yields in these treatments. Similar effects of modified land configuration have also been reported by Kantwa *et al.* (2005) [5] and Paul (2014) [9].

Effect of Irrigation levels

Seed yield ha^{-1}, straw yield (q ha^{-1}) and oil yield (q ha^{-1}) were significantly influenced due to irrigation levels. Seed yield was maximum in application of (I_3) three irrigations (13.64 q ha^{-1}), one at vegetative stage, second at flowering and third at capsule formation which were at par with (I_2) two irrigations (13.0 q ha^{-1}), one a flowering and second at capsule formation and significantly superior over (I_1) one irrigation at flowering. This clearly indicated availability of moisture increased vigour and growth of crop which helped in improving the yield components and consequently yield. These findings are in close accordance with Yenpreddiwar *et al.* (2007) [14], Jaiswal (2014) [4], Ram-Pyare *et al.* (2005) [10] and Chormule *and* Datonde (2001).

Interaction effect

Interaction effect was found to be non significant.

Effect on Soil moisture studies

The data in respect of moisture content (%) at 30 cm depth, Consumptive use (mm) and Water use efficiency (kg ha mm^{-1}) was given in Table 1.

Table 1: Growth Attributes, Yield and Soil Moisture Studies of Linseed As Influenced By Different Land Configuration Treatments and Irrigation Levels

Treatments	Growth attributes			Yield			Soil moisture studies		
Land configuration	**Plant height (cm)**	**No. of branches plant^{-1}**	**Dry matter plant^{-1} (g)**	**Seed Yield (q ha^{-1})**	**Straw Yield (q ha^{-1})**	**Oil yield (q ha^{-1})**	**Moisture content (%) at 0-30 cm depth**	**Consumptive use (mm)**	**Water use efficiency (kg ha mm^{-1})**
L_1- Flat bed	43.70	3.33	3.01	11.18	13.92	4.26	19.7	114.89	9.73
L_2- Ridges and furrow	46.15	3.66	3.37	13.15	14.89	5.07	21.1	109.77	11.97
L_3- Furrow after two rows	45.06	3.50	3.25	12.67	14.02	4.86	19.9	114.73	11.04
L_4- BBF	47.90	3.89	3.74	13.97	17.15	5.42	22.3	105.68	13.21
S E (m) ±	0.80	0.07	0.11	0.34	0.66	0.14	-	-	-
C D at 5%	2.78	0.26	0.39	1.19	2.30	0.51	-	-	-
Irrigation levels									
I_1- One irrigation	43.56	2.86	3.00	11.58	13.24	4.38	19.9	71.10	7.76
I_2- Two irrigations	46.36	3.96	3.48	13.00	15.54	5.01	20.3	95.5	13.61
I_3- Three irrigations	48.23	4.42	3.54	13.64	17.00	5.32	21.1	175.73	16.28
S E (m) ±	0.75	0.17	0.12	0.22	0.50	0.10	-	-	-
C D at 5%	2.26	0.52	0.37	0.66	1.50	0.30		-	-
Interaction									
S E (m) ±	1.51	0.35	0.25	0.44	1.00	0.20	-	-	-
C D at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	-	-	-

Effect of Land configuration

Land configuration did not show much variation in moisture content (%) of soil at various intervals throughout the crop growth period and at harvest. Higher moisture content was noticed in treatment of broad bed furrow (L_4) among various land configuration treatments. These findings are in close accordance with Suryawanshi *et al*. (2008) [11].

The flat bed recorded maximum consumptive use (114.89) followed by furrow after two rows (114.73 mm) and ridges and furrow (109.77 mm). The BBF recorded minimum consumptive use (105.68 mm). These findings are in close accordance with Patil *et al*. (2011) [7]. The higher water use efficiency was recorded by BBF (13.21 kg ha mm^{-1}) followed by ridges and furrow (11.97 kg ha mm^{-1}) and furrow after two rows (11.04 kg ha mm^{-1}). The lowest water use efficiency was recorded by flat bed treatment (9.73 kg ha mm^{-1}). These findings are in close accordance with Suryawanshi *et al*. (2008) [11].

Effect of Irrigation levels

The irrigation levels also did not show much variation in moisture due to various irrigation levels. However, maximum values were observed in treatment of three irrigations, one at vegetative stage, second at flowering and third at capsule formation (I_3) among the other irrigation levels. These findings are in close accordance with Jaiswal (2014) [4].

The lowest consumptive use of 71.10 mm recorded with one irrigation (I_1). With two irrigations, one at flowering and second at capsule formation the consumptive use was 95.50 mm, when three irrigations were given one at vegetative stage, second at flowering and third at capsule formation the consumptive use increased to 175.73 mm. These results are in tune with the findings reported by Yenpreddiwar (2006) [13]. The highest water use efficiency of (16.28 kg ha mm^{-1}) was recorded in treatment (I_3) one at vegetative stage, second at flowering and third at capsule formation followed by in (I_2) two irrigations, one at flowering and second at capsule formation (13.61 kg ha mm^{-1}). These findings are in close accordance with Patil *et al.* (2011) [7].

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