J. Soils and Crops 27 (1) 232-238, June 2017 ISSN 0971-2836

EFFECT OF DIFFERENT DATES OF SOWING AND CROP WEATHER ON LINSEED VARIETIES

D.J. Jiotode[1], Damodar Patel[2], Shanti Patil[3] and V.S.Khawle[4]

ABSTRACT

The present study was carried out to identify suitable variety and influence of sowing dates on yield of linseed during *rabi* season of 2014-2015 with linseed variety PKV NL-260 and NL-97 on field No. 11 of Agronomy farm, College of Agriculture, Nagpur. The experiment was laid out in Split Plot Design with eight treatment combinations with three replications consisting four levels of sowing date *i.e.* 40th MW (D1-1st to 7th October), 41st MW(D1-8th to 14th October), 42nd MW (D1-15th to 21st October), 43rd MW (D1-22nd to 28th October) and two varieties i.e. PKV NL-260 (V1) and NL-97 (V2). Various sowing dates significantly influenced the growth and yield of linseed varieties. Sowing of different varieties under different dates significantly influenced the plant height and various yield contributing characters such as number of capsule plant^{-1}, seed yield plant^{-1}, straw yield plant^{-1}, seed yield q ha^{-1}, straw yield q ha^{-1} and biological yield (q ha^{-1}). Among the two cultivars, PKV-NL-260 recorded the higher growth and yield attributing characters which resulted in significantly higher seed yield over the variety NL-97. In case of weather parameters, temperature requirement is highest when crop was sown on 41st MW than rest of the sowing dates. Relative humidity requirement of linseed is highest when crop sown on 42nd MW than rest of the sowing dates. From this study it is inferred that agro-meteorological sowing of linseed crop on 41st MW ie. 8th to 14th October was found suitable, while variety PKV-NL-260 performed better than NL-97.

(Key words : Linseed, dates of sowing, sowing varieties, thermal requirement, relative humidity requirement)

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important oilseed crop of central India. It has been grown from ancient time for flax (fiber) and seed purpose which is rich in oil. Linseed is a cool season crop. The temperature during the vegetative development of the crop should be moderate or cool. At the time of flowering, frost is very harmful to the crop. The crop is well suited to tracts of low rainfall and is generally raised where the average annual rainfall ranges from 45 to 75 cm. Linseed is basically an industrial oilseed crop and its each and every part is endowed with commercial and medicinal importance. Tolerance to biotic and abiotic stresses is a very important characteristic of this crop. Because of this property the survival and cultivation of linseed is prevailing in wide range of tropical, sub-tropical and temperate regions.

Linseed is unique among oilseeds as it has a high content of Omega-3 fatty acid, alpha linolenic acid (ALA). Linseed contains 35 to 45% oil with the ALA making up about 57% of the total fatty acids. Omega-3 fatty acids lower the levels of triglycerides in the blood, thereby reducing heart disease, and also show promise in the 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 of 3.36 lakh ha which produce about 1.17 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. In Maharashtra state, the total area under linseed crop is 31000 ha with 8000 tonnes production. Average yield of this crop in Maharashtra is 2.99 q ha^{-1} (Anonymous, 2013).

In view of the rapid spread of crop, studies on integrated production factor would throw much light to increase the productivity of crop, in this region. Since, the area under linseed is decreased now a day due to less yield, hence production technology suitable to its high production is needs to be perfected. As reinteracted increase in crop production can be realized by either extending the total area under this crop or by enhancing the crop productivity. To ensure high crop productivity, adoption of improved agronomic techniques is essential. Yield potential of this crop can be exploited by the use of agronomic techniques. Among them standardized agronomic practices required for realizing yield potential of linseed, sowing time

1. Asstt.Professor, Agrometerology, Agronomy Section, College of Agriculture, Nagpur
2. P.G.Student, Agronomy Section, College of Agriculture, Nagpur
3. Asstt. Professor, Botany Section, College of Agriculture, Nagpur
4. Professor, Agronomy Section, College of Agriculture, Nagpur

and varieties play pivotal role. In order to bring out country as a whole to a level on which other countries are standing as far as agricultural production is concerned, it is very essential to emphasize on such aspects. Some of the basic principles of factors contributing towards the increasing hectare^{-1} yield of crops such as suitable cultivar with required heritable potentially, proper sowing time and prevalence of congenial weather conditions. The importance of last factor besides the first two can in the least be underestimated. It is true that prevalence of congenial weather conditions is the only factor which neutralizes the good heritable potentiality of a variety under systematic agronomic practices..

Recent studies confirm that, varieties differ extensively in the physiological processes determining the yield. It has been also shown that the total yield plant^{-1} and unit^{-1} area is determined by the number of capsules and seed weight plant^{-1}. These physiological factors are also influenced by environmental factors. With this background, to identify suitable variety and influencing sowing date on yield of linseed, the present investigation was taken with the following objectives to find out the effect of temperature and relative humidity requirement on the growth and development of linseed varieties and to find out the most optimum meteorological week for sowing of linseed.

MATERIALS AND METHODS

The soil samples were drawn from randomly selected spots in each replication at five places from 0-30 cm depth before sowing with the help of screw auger. A composite sample was prepared and used to study the availability of major elements and some arrow-chemical properties. After studying the soil properties the experiment was laid out in split plot design with four treatments of dates of sowing 40th MW (D1-1st to 7th October), 41st MW(D1-8th to 14th October), 42nd MW (D1-15th to 21st October), 43rd MW (D1-22nd to 28th October) under main plot treatments and two varieties PKV NL-260 (V1) and NL-97 (V2) as sub plot treatments forming 8 treatment combinations and replicated three times in field of Agronomy section, College of Agriculture, Nagpur during *rabi* season of 2014-15. The distance between two replications was 1.2 m and 0.9 m between two plots. The gross and net plot size were 3.6 m × 4.8 m and 2.7 m × 4.2 m respectively.

The pre harvest biometric observations on plant height (cm) and dry matter accumulation plant^{-1} (g) were recorded periodically at 30, 60, 90 days after sowing and at harvest from five representative plants. The post harvest biometric observations were recorded on number of capsule plant^{-1}, number of seeds capsule^{-1}, seed yield plant^{-1} (g), seed yield ha^{-1} (q), straw yield plant^{-1} (q), biological yield ha^{-1} (q) and harvest index (%) after harvest from five representative plants. The observations on plant stand plot^{-1}and test weight of seeds (g) were recorded on plot basis. Weather parameters like temperature requirement (Thermal) of each variety also referred as thermal unit, for each calendar day during crop period, for all the treatments were calculated from daily weather data on maximum and minimum temperature as under

$$\text{Thermal requirement} = \frac{T_{Max} + T_{Min}}{2} - T_{Base}$$

Where,

T_{Max}	–	Maximum temperature
T_{Min}	–	Minimum temperature
T_{Base}	–	Base temperature (5 ^{0}C)

Base temperature is the temperature below which the physiological activities in plant practically cease and as a result plant does not show any growth. It present study base temperature for mustard crop was taken as 5 ^{0}C. Further total thermal unit requirement over crop period under each treatment was calculated by summation. Relative humidity for each crop growth period in respect of each treatment were added together so as to obtain relative humidity requirement in percentage during that crop period.

Mean relative humidity over crop period under each treatment was calculated by summation. The benefit : cost ratio was worked out by the dividing the gross monetary returns (Rs.ha^{-1}) with total cost of cultivation (Rs.ha^{-1}).

The data collected during the course of investigation was statistically analyzed by adopting standard method known as "Analysis of variance" for split plot design (Panse and Sukhatme, 1971). Wherever, the results were found significant, critical difference (C.D.) were worked out at 5 per cent level of probability for comparison of treatment means.

RESULTS AND DISCUSSION

Soil, Season and Growth

The experimental site was fairly uniform and levelled. The soil analyzed in experimental site was loamy clayey in texture, medium in nitrogen content, medium in phosphorus and rich in potash. Organic carbon content was medium and soil reaction was slightly alkaline (pH 7.7) in nature. The meteorological data presented in table 1 indicated that, there was slightly variation in the mean maximum temperature during 2014-15 as compared to their averages. The maximum temperature ranged from 25.0 ^{0}C to 37.9 ^{0}C, minimum temperature ranged from 8.3 ^{0}C to 24.7 ^{0}C and the morning relative humidity ranged from 39 to 89 per cent and the evening relative humidity ranged from 21 to 83 per cent during the growth period of the crop. The total rainfall during crop period was 42.9 mm. Crop sown on 40th MW and 41st experienced favorable temperature and moisture condition and showed better germination and crop growth. However, crop sown later on 42nd MW and 43rd MW badly affected due to heavy rainfall during germination showing poor germination and stunted growth. As the rainfall rise during germination and on seedling phase of the crop growth sown on 42nd MW and 43rd MW it affects vegetative growth, flowering, capsule formation and grain filling resulting into low yields. The temperature and moisture condition for the crop sown on the 40th MW and 41st MW were most favorable throughout the cropping period and thus showed better growth and yield.

Pre-harvest studies

The data regarding the pre harvest studies like plant stand at harvest, plant height, and dry matter accumulation plant^{-1} influenced by the different dates of sowing and varieties have been presented in table 2.

The data regarding plant count at harvest of linseed crop as affected by various treatments was found to be non significant for both the levels of treatments ie. sowing dates and varieties and also for the interaction effect.

The mean plant height increased with advancement in the age of the crop till harvest. The mean initial plant height was 18.74 cm at 30 days after sowing and increased up to 56.83 cm at harvest. The mean plant height was significantly influenced by different sowing times. The linseed sown during 41st MW recorded significantly superior plant height at 60 DAS and harvest, whereas, it was at par with 42nd MW at 30 DAS and 40th MW at 90 DAS and recorded maximum plant height at harvesting stage (58.67 cm). This might be due to congenial climatic condition for better germination and further growth and development of linseed crop. Similar results were reported by Yadav *et al.* (2005) and Mohapatra *et al*. (2009) in linseed, by Shivani and Sanjiv Kumar (2002) and Ghanbahadur and Lanjewar (2004) in mustard, who also recorded significant variation for plant height due to change in date of sowing. Dinda *et al.* (2015) also reported highest values of plant height (156.68 cm) when the crop was sown on 20th October (1st date of sowing) and inferior values was registered with the third date of sowing in mustard. The data also revealed that the height of the plant recorded at 30, 60, 90 DAS and at harvest was significantly influenced by different varieties. The variety NL-97 recorded significantly taller plants *viz.* 19.55 cm, 46.15 cm, 53.00 cm and 57.68 cm at 30, 60, 90 DAS and at harvest, respectively, whereas lower plant height was recorded by the variety PKV- NL-260. Reduction in plant height may be due to shorter life span of variety resulting in force maturity. Similar, results were reported by Yadav *et al.* (2005) and Mohapatra *et al.* (2009), who also reported significant variation in plant height due to varieties in linseed. Interaction due to sowing dates with varieties was found to be non-significant at all the stage of crop growth.

Data on dry matter production was significantly influenced by sowing time. However, sowing on 41st MW recorded higher dry matter accumulation than other sowing dates. During the present investigation, it was observed that there was a progressive decrease in dry matter accumulation as sowing was delayed and the lowest dry matter accumulation was recorded under sowing on 43rd meteorological week (D_4). Dry matter accumulation plant^{-1} was decreased due to delay in sowing. Optimum sowing period facilitates luxurious crop growth resulting in maximum dry matter accumulation. These results are in conformation with the finding reported by Siddique and Wright (2004) and Shaikh *et al.* (2009) in linseed, Sharma (2006), Singh *et al.* (2014) in mustard and Jiotode *et al.* (2015) in sesame, who also reported that dry matter accumulation plant^{-1} was decreased due to late sowing. The dry matter production at different growth stages was significantly influenced by different varieties. However, variety PKV-NL-260 recorded numerically higher dry matter production at all the growth stages. These are in accordance with the findings of Chintale (2015), who also noticed increase in dry matter accumulation in varieties which takes more period to reach 50% flowering in mustard. Interaction effect between sowing dates with varieties was found to be non-significant at all the stage of crop growth during the experimentation.

Post harvest studies

The data regarding the post harvest studies like number of capsule plant^{-1}, number of seeds capsule^{-1} , seed yield plant^{-1} (g), seed yield ha^{-1} (q), straw yield plant^{-1} (q), biological yield ha^{-1} (q), harvest index (%) and number of seeds capsule^{-1} as influenced by the different dates of sowing and varieties have been presented in table 3.

A mean number of capsule plant^{-1} was significantly influenced by different sowing dates. The sowing of linseed on 41st meteorological week recorded significantly higher number of capsule plant^{-1} (44.87) than rest of the sowing dates. This was due to better climatic condition prevailed with 41st MW sowing. Similar findings were reported by Iran-Nejad and Mazinani (2005), Yadav *et al.* (2005) and Mohapatra *et al.* (2009), who also reported decrease in number of capsule plant^{-1} with delay in sowing time in linseed. Mean number of capsule plant^{-1} was significantly influenced by the different varieties. The variety, PKV-NL-260 recorded significantly more number of capsules plant^{-1} (43.88) as compare to variety NL-97(42.61). It was found that the significant difference in number of capsule plant^{-1} might be due to more number of branches plant^{-1} and due to genetic variation. These results are in accordance with the findings reported by Ghanbahadur (2002), who also reported reduction in number of siliquae plant^{-1} in mustard may be due to genetic variation in variety. Interaction effect was found to be non-significant.

The data pertaining to mean seed yield plant^{-1} and ha^{-1} was influenced significantly by different sowing dates. Sowing of crop on 41st MW had recorded significantly higher seed yield plant^{-1} (3.24 g plant^{-1} and 8,52 q ha^{-1}) than other sowing dates. The significantly lowest seed yield (2.45 g plant^{-1}, 7.02 q ha^{-1}) was recorded under 43rd MW. This was due to fact that optimum temperature prevailed during flowering which resulted in low flower drop and more fruit setting during this period. Siddiqui and Wright (2004), Shaikh *et al.* (2009) and Mohapatra *et al.* (2009) have also supported the favorable effect of sowing times on seed yield in linseed. Significantly higher seed yield plant^{-1} and ha^{-1} (2.95 g plant^{-1}, 8.03 q ha^{-1}) was recorded by variety PKV-NL-260 over NL-97 (2.59 g plant^{-1}, 7.43 q ha^{-1}). Higher seed yield in PKV-NL-260 is attributed to higher number of branches plant^{-1} which resulted into more number of mature and productive capsules. These results are in conformation with the findings reported by Ghanbahadur (2002), who also reported reduction in seed yield plant^{-1} due to genetic variation in varieties of mustard. Dinda *et al.* (2015) also observed significant difference in the yield of mustard varieties and reported varieties with long duration (110-115 days) yielded more than varieties with less duration (95-100 days) which favours more translocation of photosynthesis from source to sink. The interaction effect between sowing times and varieties were found non-significant for seed yield plant^{-1} and ha^{-1} at harvest.

The data pertaining to straw yield plant^{-1} and ha^{-1} of linseed at harvest was significantly influenced by different sowing times. Sowing taken on 41st MW recorded significantly higher straw yield plant^{-1} (4.77 g plant^{-1} 13.21 q ha^{-1}) over other sowing dates. This was due to production of more number of branches plant^{-1} and dry matter accumulation plant^{-1}. Similar results were also reported by Yadav *et al.* (2005), Ibrahim (2009) and Mohapatra *et al.* (2009), who also reported decrease in straw yield with delay in sowing in linseed. Data also revealed that varieties PKV-NL-260 recorded significantly higher straw yield plant^{-1} and ha^{-1} (4.56 g plant^{-1}, 12.53 ha^{-1}) than NL-97 (3.81 g plant^{-1}, 11.77 ha^{-1}). The variety PKV-NL-260 produced significantly higher straw yield plant^{-1} than NL-97. This was due to more number of capsules and number of branches plant^{-1} which contributed towards increased straw yield plant^{-1} and ha^{-1}. The interaction effect between sowing times and varieties was non-significant for straw yield plant^{-1} at harvest.

Biological yield differed significantly due to various sowing dates. The crop sown at 41st MW recorded significantly higher biological yield (21.48 q ha^{-1}) than rest of the sowing dates. Sowing taken on 40th and 42nd MW was at par with each other in respect of biological yield. Sowing on 41st MW has accumulated higher photosynthates which helped in higher accumulation of dry matter which resulted in higher biological yield. Data also revealed that variety PKV-NL-260 produced significantly higher biological yield (20.39 q ha^{-1}) than the variety NL-97 (19.12 q ha^{-1}). Interaction due to sowing dates and varieties in respect of biological yield was found to be non-significant

The data in respect of harvest index as observed from the table 3 depicted the mean harvest index was 39.14 per cent. The data revealed that sowing on 41st MW recorded comparatively higher harvest index (39.66%) as compared to all other sowing dates. The harvest index was comparatively higher in linseed variety PKV-NL-260 (39.39 %) than variety NL-97. Anonymous (1997) also found that delay in sowing results in decrease in biological yield in linseed.

A mean number of seeds capsule^{-1} was significantly influenced by different sowing dates. The sowing of linseed on 41st meteorological week recorded significantly higher number of seed capsule^{-1} (8.69) than rest of the sowing dates. This was due to better climatic condition prevailed with 41st MW sowing. Similar findings were reported by Iran-Nejad and Mazimani (2005), Yadav *et al.* (2005) and Mohapatra *et al.* (2009), who also observed high number of seeds capsule^{-1} in plots sown in appropriate time and delay in sowing resulted in less number of seed capsule^{-1} in linseed. Mean number of seed & capsule^{-1} was significantly influenced by the different varieties. The linseed variety PKV-NL-260 recorded significantly more number of seed capsules^{-1} (8.20) as compared to variety NL-97(7.38). It was found that the significant difference in number of seed capsule^{-1} might be due to more translocation of photosynthates from source to sink. These results are in accordance with those reported by Yadav *et al.* (2005) and Mohapatra *et al.* (2009), who also reported difference in number of seeds capsule^{-1} in different varieties of linseed. The interaction between sowing times and varieties were non-significant in respect of number of seeds capsule^{-1} at harvest.

Weather parameters

The data on temperature requirement and relative humidity requirement are presented in table 4. The temperature requirement (GDD) for linseed was calculated by using daily maximum, minimum and base temperature of linseed. Mean thermal requirement of linseed during growth period is 23.00 thermal units. The temperature requirement (GDD) varied with sowing time. The linseed sown during 41st MW showed maximum GDD (25.17 thermal units) with respect to 40th MW (22.50 thermal units) and 43rd MW (20.83 thermal units), 42nd MW (23.50 thermal units) as more number of bright sunshine hours associated with 41st MW sowing. It might be due to difference in duration of crop growth and difference in maximum and minimum temperatures. Variety PKV-NL-260 (23.17 thermal units) recorded higher thermal requirement as compared to NL-97 (22.83 thermal units). Chintale (2015) had also drawn the same conclusions that thermal requirement varied with sowing time and varieties independently in mustard and their interaction was nonsignificant.

The relative humidity requirement for linseed was calculated by using average relative humidity during crop period. The relative humidity requirement varied with sowing dates. Sowing taken on 42nd MW recorded highest relative humidity (%) during crop period as higher number of rainy or cloudy days are associated with 42nd MW. The relative humidity requirement varied with varieties. Variety PKV-NL-260 recorded higher relative humidity during crop period as compared to NL-97. Similar to this results Chintale (2015) also reported that relative humidity requirement varied with sowing time and varieties independently in mustard and their interaction was nonsignificant.

Economic study (Benefit : cost ratio)

Mean B: C ratio of linseed crop obtained was 1.84. Highest B: C ratio of 2.03 was recorded with sowing on 41st MW as compared to other sowing dates. Increase in B:C ratio was due to significant increase in gross monetary

Table 1. Weekly weather data for the year 2014-2015 as recorded at meteorological observatory, College of Agriculture, Nagpur

	Date	MW	Temp ^{0}C		R.H. %		Total Rainfall (mm)	No. of Rainy days	Evaporation (mm)
			Max	Min	Mor	Eve			
1-7	Sept 14	36	30.0	24.7	82	74	2.7	2	2.9
8-14		37	26.8	23.7	89	83	12.4	2	2.1
15-21		38	31.3	24.2	78	62	0.8	1	3.6
22-28		39	33.5	22.9	73	50	0	0	3.6
29-05	Oct 14	40	33.0	21.7	66	39	0	0	4.1
06-12		41	33.3	22.6	67	49	0	0	4.0
13-19		42	31.6	22.5	76	52	4.6	1	4.3
20-26		43	32.0	19.9	70	48	0.1	0	4.0
27-02	Nov 14	44	30.4	17.2	72	37	0.1	0	2.7
03-09		45	32.1	16.5	60	30	0	0	4.1
10-16		46	31.3	20.6	64	49	0	0	3.0
17-23		47	30.8	14.4	48	28	0	0	2.9
24-30		48	30.3	13.0	60	28	0	0	2.7
01-07	Dec 14	49	29.9	12.9	51	24	0	0	3.1
08-14		50	29.4	14.0	66	41	0	0	2.4
15-21		51	25.0	10.3	62	35	0	0	2.2
22-28		52	26.5	8.8	60	27	0	0	2.7
30-05	Jan 15	1	25.2	15.2	79	57	0.3	0	1.9
06-12		2	25.9	7.5	59	21	0	0	3.0
13-19		3	27.0	8.3	56	26	0	0	2.8
20-26		4	27.2	14.0	65	40	0	0	2.5
27-02	Feb 15	5	27.7	12.0	61	34	0	0	3.1
03-09		6	30.1	14.6	64	37	0	0	3.5
10-16		7	29.3	14.2	66	31	1.2	1	3.6
17-23		8	31.7	14.8	50	31	0.5	1	4.1
24-02	Mar 15	9	32.5	16.8	62	36	5.1	2	4.3
03-09		10	29.8	16.2	54	32	0.2	0	3.8
10-16		11	32.5	19.0	59	37	3.7	1	3.0
17-23		12	33.5	18.5	48	25	4.8	0	0
23-29		13	37.9	20.1	39	28	6.4	0	0

Table 2. Influence of various treatments on different pre-harvest traits of linseed at different growth stages

Treatments	Plant stand at harvest (Plot^{-1})	Plant height (cm)				Dry matter accumulation plant^{-1}(g)			
		30 DAS	60 DAS	90DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Sowing Dates									
D_1 – 40th MW	492	18.74	45.50	53.00	56.83	0.23	1.34	2.25	3.04
D_2 – 41st MW	497	20.15	47.33	54.73	58.67	0.30	1.61	3.14	3.61
D_3 – 42nd MW	493	19.62	45.58	50.78	56.91	0.27	1.55	2.13	3.77
D_4 – 43rd MW	489	17.89	42.82	49.67	54.53	0.25	1.51	2.21	3.67
SE (m)±	1.46	0.31	0.26	0.58	0.24	0.02	0.06	0.09	0.12
CD at 5%	NS	1.06	0.90	1.99	0.82	0.03	0.20	0.30	0.42
Varieties									
V_1 –PKVNL-260	493	18.65	44.46	51.09	55.80	0.27	1.51	2.50	3.53
V_2 – NL-97	492	19.55	46.15	53.00	57.68	0.25	1.49	2.37	3.51
SE (m)±	0.46	0.24	0.46	0.45	0.54	0.01	0.01	0.06	0.11
CD at 5%	-	0.79	1.50	1.47	1.75	0.03	0.05	0.20	0.35
Interaction									
SE (m)±	0.91	0.49	0.92	0.90	1.08	0.02	0.03	0.12	0.21
CD at 5%	-	-	-	-	-	-	-	-	-
GM	493	19.0	45.31	52.04	56.74	0.26	1.50	2.43	3.52

Table 3. Influence of various treatments on different post-harvest traits of linseed

Treatments	Number of capsule plant^{-1}	Seed yield plant^{-1}(g)	Seed yield (q ha^{-1})	Straw yield plant^{-1} (g)	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)	No. of Seeds capsule^{-1}	B:C ratio
Sowing Dates									
D_1 – 40th MW	43.09	2.82	7.93	4.27	12.27	20.20	39.26	8.11	1.88
D_2 – 41st MW	44.87	3.24	8.52	4.77	13.21	21.48	39.66	8.69	2.03
D_3 – 42nd MW	42.82	2.57	7.45	4.12	12.17	19.50	38.21	7.55	1.79
D_4 – 43rd MW	42.20	2.45	7.02	3.60	10.96	17.83	39.38	6.79	1.67
SE (m)±	0.38	0.15	0.12	0.14	0.42	0.28	-	0.14	-
CD at 5%	1.30	0.51	0.42	0.49	1.46	0.98	-	0.48	-
Varieties									
V_1 –PKVNL-260	43.88	2.95	8.03	4.56	12.53	20.39	39.39	8.20	1.91
V_2 – NL-97	42.61	2.59	7.43	3.81	11.77	19.12	38.85	7.38	1.77
SE (m)±	0.38	0.11	0.18	0.20	0.15	0.39	-	0.13	-
CD at 5%	1.25	0.36	0.60	0.65	0.50	1.26	-	0.42	-
Interaction									
SE (m)±	0.77	0.22	0.37	0.40	0.30	0.78	-	0.26	-
CD at 5%	-	-	-	-	-	-	-	-	-
GM	43.24	2.77	7.73	4.19	12.15	19.75	39.14	7.79	1.84

Table 4. Temperature (^{0}C) and relative humidity (%) requirement for linseed as influenced by various treatments

Treatments	Temperature requirement (^{0}C)	Relative humidity (%)
Sowing dates		
D_1 – 40th MW	22.50	52.83
D_2 – 41st MW	25.17	57.83
D_3 – 42nd MW	23.50	64.17
D_4 – 43rd MW	20.83	57.79
Varieties		
V_1 –PKVNL-260	23.17	58.60
V_2 – NL-97	22.83	57.71
GM	**23.00**	**58.16**

return. Comparatively higher B: C ratio (1.91) was recorded with variety PKV-NL-260 over NL-97 (1.77).

It is summarized from this that sowing of linseed during 41[st] MW significantly improved all the growth and yield components as compared to sowing of linseed during 40[th], 42[nd] and 43[rd] MW resulted in significant increase in seed yield of linseed and yield components. Among the two different cultivars of linseed, PKV-NL-260 recorded significantly higher growth and yield components resulting in increased seed yield as compared to NL-97. The temperature requirement of linseed is more in crop sown on 41[st] MW. The relative humidity requirement of linseed is more in crop sown on 42[nd] MW.

Finally it is inferred from this study that sowing of linseed crop on D_2 (41[st] MW) would be suitable and variety V_1 (PKV-NL-260) would be better than V_2 (NL-97) which also is likely to give maximum benefit : cost ratio.

REFERENCES

Anonymous, 1997. Annual Research Report on sesame and linssed. Agronomy and Soil Science, 1997-98. pp. 9-10.

Anonymous, 2013. District socio-economic Review, 2012-13. Directorate of economic and statistic government of Maharashtra.

Chauhan, D. V. S., M. D. Lodhi and N. K. Verma, 2008. Effect of sowing dates, varieties and number of irrigations on yield attributes, yield and quality of linseed under bundelkhand condition of U. P. Agric. Sci. Digest.**28**(4):271 – 273.

Chintale, S.K. 2015. Crop weather relationship of mustard (*Brassica juncea*) under different dates of sowing. Unpublished M.Sc. thesis submitted to Dr.P.D.K.V. Akola**.**

Dinda, N.K., M.B.Ray and P.Sarkar, 2015. Effect of sowing date vis-a-sis variety of rapeseed and mustard on growth, yield and aphid infestation in gangetic plains of West Bengal. The Ecoscan. **9**(1&2): 21-24.

Ghanbahadur, M.R. 2002. Response of mustard genotypes to sowing dates and water management, Unpublished Ph.D. thesis submitted to Dr. P.D.K.V. Akola (M.S.).

Ibrahim, H. M. 2009. Effect of sowing date and N-fertilizer levels on seed yield, some yield components and oil content in flax. Alexandria J. Agric. Res. **54**(1): 19-28.

Iran-Nejad, H. and S. M. H.Mazinani, 2005. The effect of planting date on the seed yield of three varieties of oil flax in Varamin. J. Agril. Sci. **11**(4), 111-120.

Jiotode, D.J., V.S.Khawale, N.K.Sahu abd D.Patel, 2015. Effect of sowing dates on sesame cultivars. J.Soils and Crops, **22**(2): 271-275.

Panse, V.G. and P.V. Sukhatme,1971. Statistical method for Agriculture workers, IARI, New Delhi.

Mohapatra, S. C., B. S. Bishoyi, B. S. and H. K. Patra, 2009. Effect of sowing dates and varieties on production of linseed (*Linum usitatissimum* L.).Environ. and Eco. **27**(1A): 436-438.

Sahu, K. R., Y. K.Yadu and M. K. Chandrakar, 2005. Impact of different dates of sowing on the incidence of linseed thrips, Caliothrips indicus (Bagnall) on linseed crop. Environ. and Eco. **23**(2): 353- 355.

Shaikh, F. G., D. N. Gokhale, B. S. Rokade and P. J. Jadhav, 2009. Effect of sowing date on some growth characters in linseed. J. Agromet. **11**(2): 203-205

Sharma, S.K. 2006. Effect of sowing and irrigation management on growth and yield of mustard (*Brassica juncea*) Unpublished M.Sc. thesis submitted to Dr. P.D.K.V. Akola (M.S.).

Shivani, K. and Sanjeev Kumar, 2002. Response of Indian mustard (*Brassica juncea*) to sowing dates and row spacing in mid-hills of Sikkim under rainfed conditions. Indian J. Agron. **47**(3): 405-410.

Siddique, A. B. and D. Wright, 2004. Effects of date of sowing on seed yield, seed germination and vigour of peas and flax. Seed Sci. and Techn. **32**(2): 455-472(18).

Singh, A.K., A.K.Singh and P.K.Singh, 2014. Influence of dates of sowing and irrigation scheduling on growth and yield of mustard (*Brassica juncea* L.). Inter. J. Farm Sci. **4**(2): 80-85.

Yadav, R. A., O. P Mathuria and D. Singh, 2005. Studies on date of sowing and seed rate of double-purpose linseed (*Linum usitatissimum* L.). Pl. Archives. **5**(2): 503-507.

Rec. on 04.10.2015 & Acc. on 25.11.2015