RESEARCH ARTICLE

EFFECT OF DIFFERENT TILLAGE PRACTICES AND IRRIGATION SCHEDULE ON THE GROWTH AND YIELD OF LINSEED IN *ALFISOLS* OF CHHATTISGARH PLAINS

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Abstract: The field experiments was carried out at the Research-Cum-Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) to evaluate the effect of different tillage practices and irrigation schedule on the growth and yield of linseed in *Alfisols* of Chhattisgarh plains during two consecutive *rabi* seasons of 2009-10 and 2010-11. The experiment was laid out in strip-plot design with three replication. The horizontal strip treatments consisted of four tillage practices *viz.,* zero tillage (T_0), harrowing once (T_1), rotavator once (T_2) and conventional tillage (T_3) and vertical strip treatments consisted of four irrigation schedules *viz.,* one at after seeding (I_0), one at 35 DAS (I_1), two at 35 and 75 DAS (I_2) and three at 0, 35 and 75 DAS (I_3). Result indicated that plant population, plant height, dry mater accumulation plant^{-1}, number of branches plant^{-1}, leaf area index and yield were found significantly higher under conventional tillage (T_3) as compared to others. Among the irrigation schedules, treatment I_3 (three irrigations at 0, 35 and 75 DAS) recorded significantly maximum plant population, plant height, dry matter accumulation, number of branches plant^{-1}, leaf area index and yield.

Keyword: Tillage practices, Irrigation schedule, Growth and development, Linseed

INTRODUCTION

Linseed is grown after rice on marginal and sub-marginal lands with low or no-fertilizers, mostly under rainfed both as relay cropping "*utera*" in paddy fallow and as upland in unbunded fields. In *utera* cultivation, most of the farmers use broadcasting method of sowing without fertilizer application, resulting in poor soil seed moisture contact and seed may not get proper germination with decreases plant growth. Soil tillage is among the important factors affecting soil physical properties and crop yield. Among the crop production factors, tillage contributes up to 20% (Khurshid *et al.,* 2006). Tillage method affects the sustainable use of soil resources through its influence on soil properties (Hammel, 1989). The proper use of tillage can improve soil related constrains, while, improper tillage may cause a range of undesirable processes, e.g. destruction of soil structure, accelerated erosion, depletion of organic matter and fertility and disruption in cycles of water, organic carbon and plant nutrient. It has been observed that water use by a crop depends on method of seeding, tillage practices and type of distribution of root system. Very little information is available on water use, water use efficiency of linseed as affected by different seeding methods which is highly important to maximize area, production and productivity. So, there is urgent need to find out efficient tillage practices and irrigation schedule for higher production and productivity of the crop. Keeping above facts in view and considering the benefits and increased popularity of linseed, the field investigations entitled "Effect of different tillage practices and irrigation schedule on the growth and yield of linseed in *Alfisols* of Chhattisgarh plains".

MATERIAL AND METHOD

The present investigation on "Effect of different tillage practices and irrigation schedule on the growth, yield and quality of linseed after rice in *Alfisols* of Chhattisgarh plains" was carried out during *rabi* seasons of 2009-10 and 2010-11. The experiment was divided into horizontal and vertical plots under strip plot design. The horizontal plot was further divided into four tillage practices *viz.,* zero tillage (T_0), harrowing once (T_1), rotavator once (T_2) and conventional tillage (T_3) and vertical plots were divided into four irrigation schedules viz. one irrigation after seeding (I_0), one irrigation at 35 DAS (I_1), two irrigations at 35 and 75 DAS (I_2) and three irrigations at 0, 35 and 75 DAS (I_3). The layout plan of the experiment is given in Fig. 3.3. Recommended dose of nitrogen, phosphorus and potassium *i.e.,* 60:30:30 kg ha^{-1}, respectively were applied through urea, single super phosphate and muriate of potash. Entire quality of phosphorus and potash with half dose of nitrogen was applied as basal in rows. Rest of the half nitrogen was applied after first irrigation. The observation was taken by using five plant samples as per standard procedures and grain and

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straw yield were taken using net plot technique after removing two rows of border.

RESULT AND DISCUSSION

Growth characteristics

Result indicated that the plant population at initial stage and at harvest remained unaffected due to tillage on mean basis of two years. Similarly, the plant population at initial stage and at harvest did not vary significantly due to different treatment of irrigation schedules on mean basis of two years (Table 1). The soil edaphic factors such as soil impedance, aeration and temperature are modified by tillage operations, which ultimately influence the soil environment for seed germination and crop growth. In the present investigation, the initial and final plant population m^{-2} under different tillage and irrigation management was not significantly influenced which might be due to more or less optimal soil physical condition which resulted in proper seed soil contact and thereby maintaining sufficient plant population. Nowak and Sowinski (2006) reported that elimination of ploughing reduced the number of plants $metre^{-2}$ by 44 per cent compared to full tillage. Gurumurthy *et al.* (2008) also reported that the effect of irrigation regimes and their interaction with tillage was not significant for seedling emergence.

The data on plant height of linseed at different growth stages as affected by different tillage practices and irrigation schedules indicated that the plant height of linseed increased at faster rate from 30 to 60 DAS, thereafter the rate of increase was at slow pace up to the harvest. The tillage practices and irrigation schedules did not give significant influence on plant height at 30 DAS on mean basis of two years. As regards to tillage practices, at 60, 90 DAS and at harvest, treatment conventional tillage (T_3) registered significantly taller plants as compared to zero tillage (T_0) but, it was comparable to rotavator once (T_2) and harrowing once (T_1) on mean basis of two years. Regarding irrigation schedules, at 60, 90 DAS and at harvest, treatment of three irrigations at 0, 35 and 75 DAS (I_3) recorded significantly taller plants of linseed than treatment one irrigation after seeding (I_0) and one irrigation at 35 DAS (I_1), however it was statistically similar to two irrigations at 35 and 75 DAS (I_2) on mean basis of two years (Table 2). Increasing plant height with increasing tillage may be due to decrease bulk density which increased proliferation of root for the uptake of nutrients as well as moisture. This corroborate with the earlier findings of Mukherjee (2008) and Wasaya *et al.* (2012).

The observation on number of branches $plant^{-1}$ at various growth stages as influenced by different tillage practices and irrigation schedules showed that the different tillage practices significantly influenced the number of branches $plant^{-1}$ at all the stages except at 30 DAS. Conventional tillage (T_3) system recorded maximum number of branches $plant^{-1}$ at 60 , 90 DAS and at harvest stage, which was significantly higher with those recorded under zero tillage (T_0) but remained on par with harrowing once (T_1) and rotavator once (T_2) on mean basis of two years. Irrigation schedules had appreciable impact on formation of branches in linseed. At 30 DAS, number of branches $plant^{-1}$ did not vary significantly due to irrigation schedules during both the years and on mean basis. Among irrigation schedules, significantly higher number of branches $plant^{-1}$ at 60, 90 DAS and at harvest stage was recorded under three irrigations at sowing, 35 and 75 DAS (I_3) as compared to one irrigation after seeding (I_0) and one irrigation at 35 DAS (I_1), but it was at par with two irrigations at 35 and 75 DAS (I_2) on mean basis of two years (Table 1).

Periodic data pertaining to leaf area index (LAI) of linseed as affected by tillage practices and irrigation schedules indicated that there was visible difference in LAI of the crop due to tillage and irrigation schedules. There was progressive increase in LAI up to 60 DAS. Different tillage practices and irrigation schedules failed to give significant influence on leaf area index at 30 DAS on mean basis of two years. At 60 DAS and 90 DAS, the leaf area index was significantly highest in conventional tillage (T_3) over zero tillage (T_0), but it was on par with rotavator once (T_2) and harrowing once (T_1) during both years and also on mean basis. As regards to irrigation schedules, at 60 DAS and at 90 DAS, significantly higher LAI was recorded under I_3 (three irrigations at sowing, 35 and 75 DAS) as compared to I_0 (one irrigation after seeding) and I_1 (one irrigation at 35 DAS) treatments but stand numerically at par with those obtained under I_2 (two irrigations at 35 and 75 DAS) on mean basis of two years (Table 2). Similar results were reported for groundnut by Khan (1984).

Different tillage practices and irrigation schedules did not significantly influence the dry matter accumulation $plant^{-1}$ at 30 DAS on mean basis of two years. At 60, 90 DAS and at harvest stage of crop growth, dry matter accumulation $plant^{-1}$ was significantly higher under conventional tillage (T_3) than that recorded in zero tillage (T_0) but was on par with that of harrowing once (T_1) and rotavator once (T_2) on mean basis of two years. In other word there was steady reduction in dry matter accumulation in zero tillage (T_0), harrowing once (T_1) and rotavator once (T_2) treatments as compared to conventional tillage (T_3) treatment. Dry matter accumulation showed significant variation due to different irrigation schedules. Significantly highest amount of dry matter was accumulated by the crop at 60, 90 DAS and at harvest under three irrigations at 0, 35 and 75 DAS (I_3) over one irrigation after seeding (I_0)

treatment but was on par with two irrigations at 35 and 75 DAS (I_2) on mean basis of two years. Compared to fully irrigated crop with three irrigations at 0, 35 and 75 DAS (I_3), there was significant reduction of dry matter accumulation due to one irrigation after seeding (I_0), one irrigation at 35 DAS (I_1) and two irrigations at 35 and 75 DAS (I_2).

Yield

The seed yield of linseed was prominently influenced by tillage practices and irrigation schedules. Linseed crop grew with conventional tillage (T_3) resulted in highest seed yield of 10.58, 10.47 and 10.52 q ha^{-1} on mean basis of two years, being significantly superior compared to respective seed yield of 7.42, 7.18 and 7.30 q ha^{-1} under zero tillage (T_0). However, it was at par to treatment harrowing once (T_1) and rotavator once (T_2) on mean basis of two years. As regards to different irrigation schedules, linseed crop grew with three irrigation *viz.*, at sowing, 35 and 75 DAS (I_3) produced significantly higher seed yield compared to one irrigation after seeding (I_0) and one irrigation at 35 DAS (I_1), but it was at par to two irrigations at 35 and 75 DAS (I_2) on mean basis of two years. Seed yield of linseed differed significantly due to interaction effects of tillage practices and irrigation schedules during both the years and on mean basis (Table 2). At the same or different level of tillage, the maximum seed yield was obtained with conventional tillage combined with maximum irrigation (T_3 x I_3) which was significantly superior over other interactions, but it was at par to interaction between harrowing once x three irrigations at 0, 35 and 75 DAS (T_1 x I_3), rotavator once x three irrigations at 0, 35 and 75 DAS (T_2 x I_3) and conventional tillage x two irrigations at 35 and 75 DAS (T_3 x I_2) on mean basis of two years. Among the different tillage practices, maximum mean seed yield was obtained for treatment conventional tillage (10.52 q ha^{-1}) followed in decreasing order by rotavator once (9.27 q ha^{-1}), harrowing once (9.09 q ha^{-1}) and zero tillage (7.30 q ha^{-1}) (Table 3). The maximum yield in conventional tillage may be due to better pulverisation of soil resulting in proper seed and soil contact, which caused good germination (plants m^{-2}). The lowest yield was observed in treatment zero tillage because of poor seed and soil contact, as the clod size was big and did not create good tilth for proper germination of crop (plants m^{-2}). This increase in seed yield was due to significant increase in growth parameters and yield attributes. Seed yield increased significantly with the increase of irrigation schedule. Maximum mean seed yield (11.45 q ha^{-1}) was obtained under irrigation schedule three irrigations at 0, 35 and 75 DAS (I_3) which was 9.43 and 30.65 per cent higher than two irrigations at 35 and 75 DAS (I_2) and one irrigation at 35 DAS (I_1), respectively. This increase in seed yield was due to significant increase in growth parameters and yield attributes. The increase in grain yield with the higher level of irrigation were also reported by Gautam *et al.* (2000) and Mishra *et al.* (2002). Significantly higher growth parameters due to high irrigation levels were also reported by Bandopadhyay and Mallick (2000).

The stalk yield varied significantly due to tillage practices and irrigation schedules on mean basis of two years. A perusal of the data indicates that crop planted under conventional tillage (T_3) has been given significantly higher stalk yield than zero tillage (T_0), but it was at par to harrowing once (T_1) and rotavator once (T_2) on mean basis of two years (Table 2). It is clear from the result that different irrigation schedules influenced the stalk yield of linseed. Linseed crop provided with three irrigations *viz.*, at sowing, 35 and 75 DAS (I_3) resulted in significantly higher stalk yield, being significantly superior over one irrigation after seeding (I_0) and one irrigation at 35 DAS (I_1) but remained at par to two irrigations at 35 and 75 DAS (I_2) on mean basis of two years.

Increasing tillage also resulted in significant increase in the stalk yield. Significantly maximum stalk yield was recorded under conventional tillage (T_3) and it was 7.38 and 6.78 % higher over harrowing once (T_1) and rotavator once (T_2), respectively. This increase in stalk yield could be due to the increase in LAI, dry matter accumulation and plant height. Indirectly, it may also have contributed for higher yield because higher stalk yield. Significantly maximum stalk yield was recorded under three irrigations at 0, 35 and 75 DAS (I_3) and it was 5.49 and 13.96 % higher over two irrigations at 35 and 75 DAS (I_2) and one irrigation at 35 DAS (I_1), respectively. Adequate available soil moisture in the root zone depth of soil due to frequent irrigation might have improved the nutrient availability, thereby increasing cell division and cell expansion which in turn increased the total dry matter production at three irrigation. Panchanathan *et al.* (1992) observed that when the crop was supplied with adequate moisture throughout the growing period and reduction was noticed with imposition of moisture stress. This indicate that moisture supply has a direct bearing on the production of ultimate stalk yield.

Table 1. Plant population of linseed at different growth stages as influenced by tillage practices and irrigation schedule (mean of two years)

	Plant population (No. m^{-2})		Plant height (cm)				Number of branches plant^{-1}			
Treatment	**At Initial stage (20 DAS)**	**At Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At Harvest**	**30 DAS**	**60 DAS**	**90 DAS**	**At Harvest**
Tillage practices										
T_0 : Zero tillage	36.04	33.96	22.95	44.04	53.77	54.82	2.55	22.21	23.19	22.48
T_1 : Harrowing once	37.50	35.83	23.20	55.65	65.16	66.90	2.67	23.33	26.74	27.15
T_2 : Rotavator once	38.07	35.63	23.23	55.93	66.25	66.92	2.73	24.03	27.07	27.33
T_3 : Conventional tillage	38.54	37.75	23.60	57.88	68.68	68.92	2.81	27.55	30.29	29.88
SEm±	**1.33**	**1.34**	**0.57**	**0.84**	**0.71**	**0.76**	**0.78**	**1.13**	**1.20**	**0.84**
CD (P=0.05)	**NS**	**NS**	**NS**	**2.53**	**2.50**	**2.65**	**NS**	**3.97**	**4.25**	**2.93**
Irrigation schedule										
I_0 : One (After seeding)	37.92	34.63	23.06	51.15	61.45	62.66	2.63	22.13	23.68	23.86
I_1 : One (35 DAS)	35.71	35.05	23.15	51.83	63.08	63.28	2.69	22.78	24.26	24.62
I_2 : 35 and 75 DAS	37.34	36.00	23.36	54.52	64.07	64.93	2.71	24.68	28.36	27.64
I_3 : 0, 35 and 75 DAS	39.00	37.50	23.43	55.50	66.26	66.70	2.72	27.52	30.98	30.72
SEm±	**1.28**	**1.18**	**0.44**	**0.60**	**0.69**	**0.83**	**0.19**	**0.86**	**1.02**	**0.94**
CD (P=0.05)	**NS**	**NS**	**NS**	**2.10**	**2.40**	**2.90**	**NS**	**2.94**	**3.54**	**3.25**

Table 2. Number of branches of linseed at different growth stages as influenced by tillage practices and irrigation schedule schedule (mean of two years)

Treatment	**Leaf area index**			**Dry matter accumulation (g plant^{-1})**				**Yield (q ha^{-1})**	
	30 DAS	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**At Harvest**	**Seed yield**	**Stalk yield**
Tillage practices									
T_0 : Zero tillage	0.212	0.531	0.517	0.284	1.88	4.06	5.46	7.30	18.22
T_1 : Harrowing once	0.248	0.887	0.881	0.284	2.18	5.42	6.33	9.09	21.43
T_2 : Rotavator once	0.240	0.887	0.877	0.276	2.25	5.39	6.50	9.27	21.57
T_3 : Conventional tillage	0.252	1.034	1.012	0.286	3.09	6.08	7.42	10.52	23.14
SEm±	**0.055**	**0.047**	**0.041**	**0.06**	**0.25**	**0.20**	**0.28**	**0.63**	**0.49**
CD (P=0.05)	**NS**	**0.152**	**0.147**	**NS**	**0.87**	**0.72**	**1.02**	**2.18**	**1.71**
Irrigation schedule									
I_0 : One (After seeding)	0.206	0.671	0.666	0.280	1.91	4.31	5.42	6.42	17.46
I_1 : One (35 DAS)	0.236	0.695	0.689	0.283	2.18	4.96	6.30	7.94	20.52
I_2 : 35 and 75 DAS	0.240	0.878	0.904	0.288	2.34	5.58	6.43	10.37	22.54
I_3 : 0, 35 and 75 DAS	0.269	1.095	1.027	0.287	2.96	6.10	7.56	11.45	23.85
SEm±	**0.044**	**0.069**	**0.045**	**0.05**	**0.27**	**0.16**	**0.39**	**0.32**	**0.59**
CD (P=0.05)	**NS**	**0.239**	**0.150**	**NS**	**1.02**	**0.58**	**1.37**	**1.19**	**2.05**

Table 3. Interaction effect of tillage practices and irrigation schedule on seed yield of linseed (mean of two years)

Tillage practices / **Irrigation schedule**	**Seed yield (q ha^{-1})**				
	T_0 (Z T)	**T_1 (Harrowing)**	**T_2 (Rotavator)**	**T_3 (C T)**	**Mean**
I_0 : One (After seeding)	5.05	6.35	6.42	7.87	**6.42**
I_1 : One (35 DAS)	5.22	8.45	8.47	9.63	**7.94**
I_2 : 35 and 75 DAS	8.88	10.22	10.67	11.73	**10.38**
I_3 : 0, 35 and 75 DAS	10.05	11.35	11.55	12.85	**11.45**
Mean	**7.30**	**9.09**	**9.28**	**10.52**	
				Mean	
Tillage at same level but Irrigation at diff. levels		**SEm±**		**0.69**	
		CD (P =0.05)		**1.98**	
Irrigation at same level but Tillage at diff. levels		**SEm±**		**0.56**	
		CD (P =0.05)		**1.63**	

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