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Effect of planting pattern and weed management on weeds and weed indices in linseed (*Linum usitatissimum* L.) + chandrasur (*Lepidium sativum* L.) intercropping system

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Abstract

The experiment was carried out in Split plot design with three replications. In main plots treatment consisted of five planting pattern viz., T₁- Sole linseed, T₂- Sole chandrasur, T₃- Linseed +chandrasur (1:1), T₄- Linseed +chandrasur (2:1), T₅- Linseed +chandrasur (2:2) and four weed management treatment combination viz., W₁- Oxadiargyl @ g ha⁻¹ pre- emergence fb one hand weeding at 20 DAS, W₂- Mechanical weeding by cycle hoe + hand pulling intra rows at 25 DAS fb one hand weeding at 40 DAS, W₃- Hand weeding (20, 40 DAS), W₄- Weedy check were assigned in sub plots. The findings revealed that planting pattern and weed management had significant influenced on weeds and weed indices. The significantly minimum total weed density and dry weight was recorded under T₅- linseed+chandrasur (2:2) row ratio, but it was at par to T₄- linseed + chandrasur (2:1) row ratio and T₃- linseed + chandrasur (1:1) row ratio during both the years and on mean basis. As regards to weed management practices, significantly minimum weed density and dry weight was observed under W₃ - Hand weeding (20, 40 DAS), but it was at par to W₂-Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS) during both the years and on mean basis. The minimum weed index (25.36, 27.78 and 23.15%) was recorded under W₃- Hand weeding twice (20 and 40 DAS) and maximum weed smothering efficiency (73.79, 73.82 and 17.81%) was recorded under T₅- linseed +chandrasur (2:2) row ratio followed by T₄- linseed + chandrasur (2:1) row ratio recorded (69.50, 70.99 and 70.50%) and the minimum weed smothering efficiency (54.40, 56.92 and 55.86%) was recorded under T₁- sole linseed during both the years and on mean basis, respectively.

Keywords: Linseed, chandrasur, intercropping, pre-emergence, hand weeding, weed indices

Introduction

Linseed or flax is among the oldest crop plants cultivated for the purpose of oil and fibre. It belongs to family Linaceae. Seed contains 33 to 47 per cent oil. Seeds of linseed contain high levels of dietary fibers, micronutrients and omega-3 fatty acids. Linseed has two major fatty acids, 57% α linoleic acid (ω -3) and 16% linoleic acid ω -6 (Morris, 2007) [8]. The area under linseed crop cannot be increased because of the inflexibility of existing cropping systems. Hence, the only way to increase the productivity of such crops is to grow them in association with other crops in such a pattern that the productivity of the base crop is least affected by the associated crop and the production per unit area is also increased. Chandrasur is commonly known as Garden Cress. It is belonging to the Brassicaceae family. Chandrasur is also widely cultivated in temperate countries for various culinary and medicinal purposes. Nutritive value of its leaves and seeds is very high. Chandrasur seeds contain 18-25% protein, 14-24% lipids, 33-54% carbohydrates and 8% crude fiber (Sharma, 2020) [14]. The seeds are strong antioxidant. They have anti-diabetic, cholesterol lowering, blood pressure lowering, liver protective and it has good anti cancer property. The seeds are good source to enhance the milk percentage in cattle as well as in nursing mother. Both these crops may form a perfect combination for improving their productivity and profitability. The slow initial growth with lower canopy spread leads to dominance of weeds over the crop. An initial growth period of 25-45 days is very critical and season long weed competition has been found to reduce linseed and chandrasur yield to the extent of 30-40% (Mahere *et al.*, 2000) [7] depending on the type and intensity of weed flora. Farmers rely predominately on manual weeding, a traditional method of weed control in oilseeds in general and linseed in particular. Weed competition has become a major constraint in limiting yield of any crop. Among the total annual losses of agricultural product from various pest, weeds account for 45%, insects for 30%, diseases 20% and other pest 5% (Rao, 2000) [12]. Weed management is an important aspect of soil-related crop production.

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Materials and Methods

The experiment was carried out in Split plot design with three replications. In main plots, treatment consisted of five planting pattern viz., T₁- Sole linseed, T₂- Sole chandrasur, T₃- Linseed +chandrasur (1:1), T₄- Linseed +chandrasur (2:1), T₅- Linseed +chandrasur (2:2) and four weed management treatment viz., W₁- Oxadiargyl @ g ha⁻¹ pre- emergence fb one hand weeding at 20 DAS, W₂- Mechanical weeding by cycle hoe + hand pulling intra rows at 25 DAS fb one hand weeding at 40 DAS, W₃- Hand weeding (20, 40 DAS), W₄- Weedy check were assigned in sub plots. Application of fertilizer in sole linseed was 60:30:30 N, P₂O₅, K₂O kg ha⁻¹, whereas in case sole chandrasur, was 50:40:30 N, P₂O₅, K₂O kg ha⁻¹. Uniform dose of recommended fertilizer (RDF) was applied. Full dose of phosphorus and potassium was applied at the time of sowing, while only half of the recommended dose of nitrogen was applied at the time of sowing. The remaining half dose of nitrogen was top dressed at 25 days

after sowing. The crop varieties used during experimentation are 'RLC-161' for linseed and 'GA-1' for chandrasur. Experimental data obtained was compiled and subjected to statistical analysis by adopting Fischer's method of analysis of variance (Gomez and Gomez, 1984) [1]. The critical difference values given in the table at 5% level of significance were used. Weed parameters such as weed density and weed dry weight analyzed by the square root transformation value $\sqrt{x+0.5}$.

Results and Discussion

The various weed species observed during two years of experimentation indicated that the *Medicago denticulata*, *Cyperus rotandus*, *Cynodon dactylon* were major weeds, while the density of *Melilotus indica*, *Chenopodium album*, *Alternanthera sessilis*, *Echinochloa colona* and *Physallis minima* were observed lesser and grouped as other weed.

Table 1: Effect of planting pattern and weed management on total weed density (No. m⁻²) at 30 DAS, 60 DAS, 90 DAS and at harvest stage in linseed+ chandrasur intercropping system

Treatment	30 DAS			60 DAS			90 DAS			At harvest stage		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Planting pattern												
T ₁ :	3.74 (16.98)	4.20 (20.70)	3.97 (19.34)	4.86 (27.51)	5.25 (33.63)	5.07 (30.57)	5.70 (40.43)	6.22 (48.71)	5.96 (44.57)	5.39 (35.30)	5.89 (42.63)	5.64 (38.97)
T ₂ :	3.79 (17.56)	4.15 (20.95)	3.97 (19.25)	4.62 (25.28)	4.99 (30.30)	4.81 (27.79)	5.41 (35.78)	5.98 (44.68)	5.70 (40.23)	5.19 (32.18)	5.69 (39.57)	5.44 (35.88)
T ₃ :	3.79 (16.90)	4.07 (20.26)	3.93 (18.58)	4.25 (21.90)	4.71 (27.25)	4.49 (24.57)	5.04 (30.76)	5.62 (39.51)	5.33 (35.14)	4.88 (29.00)	5.38 (35.45)	5.13 (32.23)
T ₄ :	3.10 (11.91)	3.59 (15.85)	3.35 (13.88)	3.95 (19.05)	4.43 (23.96)	4.20 (21.50)	4.80 (27.46)	5.30 (35.28)	4.81 (31.37)	4.65 (25.88)	5.11 (32.58)	4.88 (29.23)
T ₅ :	3.24 (12.93)	3.71 (17.46)	3.48 (15.20)	3.66 (16.93)	4.24 (22.13)	3.96 (19.53)	4.43 (23.61)	5.07 (32.36)	4.75 (27.99)	4.35 (23.02)	4.89 (29.82)	4.62 (26.42)
SEm±	0.09	0.07	0.07	0.18	0.16	0.13	0.18	0.17	0.14	0.19	0.17	0.16
CD (P= 0.05)	0.32	0.23	0.25	0.60	0.52	0.45	0.59	0.56	0.46	0.63	0.57	0.52
Weed management												
W ₁ :	2.73 (7.13)	2.99 (8.56)	2.86 (7.84)	3.52 (12.18)	3.80 (14.10)	3.67 (13.14)	4.17 (17.09)	4.44 (19.46)	4.31 (18.28)	4.01 (15.76)	4.28 (18.04)	4.14 (16.90)
W ₂ :	2.03 (3.82)	2.33 (5.05)	2.18 (4.44)	2.95 (8.56)	3.24 (10.22)	3.10 (9.39)	3.53 (12.08)	3.80 (14.18)	3.66 (13.13)	3.42 (11.36)	3.72 (13.57)	3.57 (12.47)
W ₃ :	2.85 (7.77)	3.10 (9.28)	2.98 (8.52)	2.87 (8.02)	3.15 (9.56)	3.02 (8.79)	3.38 (11.06)	3.68 (13.22)	3.53 (12.14)	3.30 (10.56)	3.60 (12.67)	3.46 (11.61)
W ₄ :	6.52 (42.30)	7.37 (54.09)	6.94 (48.20)	7.72 (59.77)	8.70 (75.93)	8.23 (67.85)	9.23 (86.21)	10.62 (113.57)	9.93 (99.89)	8.84 (78.63)	9.96 (99.76)	9.40 (89.19)
SEm±	0.09	0.08	0.08	0.11	0.09	0.07	0.11	0.13	0.09	0.10	0.14	0.10
CD (P= 0.05)	0.28	0.25	0.24	0.33	0.28	0.21	0.34	0.40	0.28	0.31	0.41	0.29

Note: T₁-Sole linseed, T₂ Sole chandrasur, T₃- Linseed +Chandrasur (1:1), T₄- Linseed + Chandrasur (2:1), T₅- Linseed +Chandrasur(2:2), W₁- Oxadiargyl @ 80 g ha⁻¹ pre- emergence fb one hand weeding at 20 DAS, W₂: Mechanical weeding by cycle hoe + hand pulling intra rows at 25 DAS fb one hand weeding at 40 DAS, W₃: Hand weeding (20, 40 DAS), W₄: Weedy check

Table 2: Effect of planting pattern and weed management on total weed dry weight (g m⁻²) at 30 DAS, 60 DAS, 90 DAS and at harvest stage in linseed+ chandrasur intercropping system

Treatment	30 DAS			60 DAS			90 DAS			At harvest		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Planting pattern												
T ₁ :	2.40 (6.00)	2.86 (8.43)	2.63 (7.22)	3.59 (13.46)	3.98 (16.75)	3.80 (15.11)	4.38 (20.66)	4.96 (27.36)	4.67 (24.01)	4.59 (22.93)	5.16 (29.81)	4.87 (26.37)
T ₂ :	2.50 (6.54)	2.81 (8.02)	2.65 (7.28)	3.36 (11.66)	3.75 (14.85)	3.56 (13.25)	4.18 (18.65)	4.75 (24.43)	4.47 (21.54)	4.37 (20.43)	4.95 (26.80)	4.66 (23.62)
T ₃ :	2.42 (6.01)	2.76 (7.73)	2.59 (6.87)	3.15 (10.21)	3.43 (12.43)	3.29 (11.32)	3.83 (15.61)	4.36 (20.61)	4.09 (18.11)	3.99 (16.98)	4.53 (22.50)	4.26 (19.74)
T ₄ :	1.95 (3.77)	2.31 (5.26)	2.13 (4.52)	2.85 (8.49)	3.20 (10.75)	3.03 (9.62)	3.64 (13.88)	4.12 (18.33)	3.88 (16.10)	3.83 (15.33)	4.29 (20.08)	4.06 (17.71)
T ₅ :	2.05	2.45	2.25	2.64	3.00	2.83	3.40	3.93	3.67	3.54	4.09	3.81

	(4.21)	(6.12)	(5.16)	(7.36)	(9.57)	(8.47)	(12.14)	(16.64)	(14.39)	(13.17)	(18.12)	(15.65)
SEm±	0.05	0.11	0.11	0.12	0.09	0.10	0.12	0.12	0.10	0.14	0.11	0.11
CD (P= 0.05)	NS	NS	NS	0.42	0.32	0.34	0.40	0.39	0.33	0.44	0.38	0.36
Weed management												
W ₁ :	2.20 (4.48)	2.56 (6.21)	2.38 (5.35)	2.96 (8.46)	3.26 (10.28)	3.12 (9.37)	3.66 (13.11)	4.00 (15.65)	3.83 (14.38)	3.84 (14.47)	4.17 (17.06)	4.01 (15.76)
W ₂ :	1.24 (1.10)	1.64 (2.26)	1.44 (1.68)	2.48 (5.87)	2.74 (7.19)	2.62 (6.53)	3.09 (9.21)	3.46 (11.63)	3.27 (10.42)	3.23 (10.09)	3.56 (12.33)	3.40 (11.21)
W ₃ :	2.33 (5.13)	2.73 (7.09)	2.53 (6.11)	2.40 (5.44)	2.65 (6.65)	2.53 (6.05)	2.98 (8.48)	3.36 (10.96)	3.17 (9.72)	3.09 (9.18)	3.42 (11.35)	3.26 (10.27)
W ₄ :	3.28 (10.51)	3.63 (12.89)	3.46 (11.70)	4.63 (21.16)	5.24 (27.36)	4.95 (24.26)	5.82 (33.96)	6.88 (47.65)	6.35 (40.81)	6.09 (37.33)	7.26 (53.11)	6.68 (45.22)
SEm±	0.08	0.08	0.08	0.06	0.08	0.04	0.08	0.10	0.07	0.08	0.11	0.08
CD (P= 0.05)	0.24	0.24	0.23	0.19	0.23	0.13	0.24	0.30	0.22	0.25	0.32	0.23
T X W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: T₁-Sole linseed, T₂ Sole chandrasur, T₃- Linseed +Chandrasur (1:1), T₄- Linseed + Chandrasur (2:1), T₅- Linseed +Chandrasur(2:2), W₁-Oxadiargyl @ 80 g ha⁻¹ pre- emergence fb one hand weeding at 20 DAS, W₂: Mechanical weeding by cycle hoe + hand pulling intra rows at 25 DAS fb one hand weeding at 40 DAS,W₃: Hand weeding (20, 40 DAS),W₄: Weedy check

Table 3: Effect of plating pattern and weed management on weed index, weed control efficiency and weed smothering efficiency in linseed (*Linum usitatissimum* L.) + chandrasur (*Lepidium sativum* L.) intercropping system

Treatment	Weed index (%)			Weed smothering efficiency (%)		
	2020-21	2021-22	Mean	2020-21	2021-22	Mean
Planting pattern						
T ₁ : Sole linseed	-	-	-	54.40	56.92	55.86
T ₂ : Sole chandrasur	-	-	-	59.37	61.27	60.47
T ₃ : Linseed + Chandrasur (1:1)	-	-	-	66.21	67.49	66.95
T ₄ : Linseed + Chandrasur (2:1)	-	-	-	69.50	70.99	70.50
T ₅ : Linseed + Chandrasur (2:2)	-	-	-	73.79	73.82	73.81
Weed management						
W ₁ : Oxadiargyl @ 80 g ha ⁻¹ pre- emergence fb one hand weeding (20 DAS)	29.40	31.99	27.36	71.21	75.35	73.61
W ₂ : Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS)	26.43	28.77	24.18	79.92	82.17	81.23
W ₃ : Hand weeding (20, 40 DAS)	25.36	27.78	23.15	81.73	83.59	82.81
W ₄ : Weedy check	61.23	61.08	61.17	25.76	23.28	24.43

Weed density

The data with respect to weed density was recorded in different growth intervals effect on weed density during the years and on mean basis. As regards to planting pattern, significantly minimum total weed density was recorded under T₄-linseed+chandrasur (2:1) row ratio, but it was at par to T₅-linseed + chandrasur (2:2) row ratio at 30 DAS. At 60 DAS, significantly minimum total weed density was recorded under T₅-linseed+chandrasur (2:2) row ratio, but it was at par to T₄-linseed + chandrasur (2:1) row ratio and T₃- linseed + chandrasur (1:1) row ratio during both the years and on mean basis. Similar result was found at 90 DAS and at harvest stage, significantly minimum total weed density was recorded under T₅-linseed+chandrasur (2:2) row ratio, but it was at par to T₄- linseed + chandrasur (2:1) row ratio during both the years and on mean basis, as well as T₃- linseed + chandrasur (1:1) row ratio during second year only at 90 DAS. Similar findings were reported by Sharma and Banik (2013) [15], Kithan and Longkumar (2016) [2] and Koocheki *et al.* (2019) [3].

As regards to weed management practices, significant variation was found on weed density at 30, 60, 90 DAS and at harvest stage. At 30 DAS, significantly minimum weed density was observed under W₂ -Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS) during both the years and on mean basis. At 60 DAS, significantly minimum weed density was observed under W₃ -Hand weeding (20, 40 DAS), but it was at par to W₂-Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS) during both the years and mean basis. Similar result was found at 90

DAS and at harvest stage during both the years and on mean basis. Similar findings were reported by Singh *et al.* (2002) [16] and Kumar *et al.* (2020) [5]. Interaction effect between various planting pattern and weed management practices showed non significant variation on weed density during both the years and on mean basis.

Weed dry weight

The data with respect to weed dry weight was recorded in different growth intervals and presented in Table 2. The findings revealed that planting pattern had significant effect on weed dry weight during both the years and on mean basis except 30 DAS. As regards to planting pattern, significantly minimum total weed dry weight was recorded under T₄-linseed+chandrasur (2:1) row ratio, but it was at par to T₅-linseed + chandrasur (2:2) row ratio at 60 DAS. Similar pattern of result was found at 90 DAS and at harvest stage during both the years and on mean basis. Similar findings were reported by Sharma and Banik (2013) [15], Kithan and Longkumar (2016) [2] and Koocheki *et al.* (2019) [3].

As regards to weed management practices, significant variation was found on weed dry weight except at 30 DAS. At 60 DAS, significantly minimum weed density was observed under W₃ -Hand weeding (20, 40 DAS), but it was at par to W₂-Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS) during both the years and mean basis. Similar result was found at 90 DAS and at harvest stage during both the years and on mean basis. Similar findings were reported by Singh *et al.* (2002) [16] and Kumar *et al.* (2020) [5]. Interaction effect between various planting pattern and weed management practices showed non

significant variation on weed dry weight during both the years and on mean basis.

Weed index

The data with respect to weed index was influenced by different planting pattern and weed management practices during both the years and on mean basis and presented in Table-3. As regards to weed management practices, the minimum weed index (25.36, 27.78 and 23.15%) recorded under W₃- Hand weeding twice (20 and 40 DAS) and maximum weed index was ((61.23, 61.08 and 61.17%) recorded W₄- weedy check during both the years and on mean basis, respectively. This might due hand weeding control weeds (total weeds) as compared to rest of the treatment. Similar findings were reported by Singh *et al.* (2002) ^[16], Rathi *et al.* (2007) ^[13] and Kumar *et al.* (2015) ^[4].

Weed smothering efficiency

As regards to planting pattern, the maximum weed smothering efficiency (73.79, 73.82 and 17.81%) was recorded under T₅- linseed +chandrasur (2:2) row ratio followed by T₄- linseed + chandrasur (2:1) row ratio recorded (69.50, 70.99 and 70.50%) at harvest stage during both the years and on mean basis, respectively and the minimum weed smothering efficiency (54.40, 56.92 and 55.86%) recorded under T₁- sole linseed. This might be due to less photosynthetic active radiation was available to weed canopy in intercropping system may be attributes to hang up of weed growth and reduced crop weed competition which leads to lower dry matter production, ultimately suppress the weed growth. The basic mechanisms for weed suppression in intercropping are more effective resource usurping from weeds compared to sole cropping (Liebman and Dyck, 1993) ^[6]. Similar findings reported by Omovbude *et al.* (2017) ^[10] and Pradhan *et al.* (2018) ^[11]. As regards to weed management practices, the maximum weed smothering efficiency (81.73, 83.59 and 82.81%) was recorded under W₃- Hand weeding (20 and 40 DAS) and minimum weed smothering efficiency (25.76, 23.28 and 24.43%) recorded under W₄- weedy check during both the years and on mean basis, respectively. Similar findings were reported by Singh *et al.* (2002) ^[16], Rathi *et al.* (2007) ^[13] and Naher *et al.* (2018) ^[9].

Conclusion

On the basis of two years findings of experimentation on linseed + chandrasur intercropping system the following conclusion can be drawn. The significantly minimum total weed density and dry weight was recorded under T₅-linseed+chandrasur (2:2) row ratio, but it was at par to T₄-linseed + chandrasur (2:1) row ratio. As regards to weed management practices, significantly minimum weed density and dry weight was observed under W₃ -Hand weeding (20, 40 DAS), but it was at par to W₂-Mechanical weeding by cycle hoe + hand pulling intra rows (25 DAS) fb one hand weeding (40 DAS) during both the years and on mean basis. The minimum weed index (25.36, 27.78 and 23.15%) was recorded under W₃- Hand weeding twice (20 and 40 DAS) and maximum weed smothering efficiency (73.79, 73.82 and 17.81%) was recorded under T₅- linseed +chandrasur (2:2) row ratio followed by T₄- linseed + chandrasur (2:1) row ratio recorded (69.50, 70.99 and 70.50%) and the minimum weed smothering efficiency (54.40, 56.92 and 55.86%) was recorded under T₁- sole linseed during both the years and on mean basis, respectively.

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