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Comparative evaluation of happy seeder technology with other sowing methods and weed management practices in linseed under rice - based cropping system in conservation agriculture

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Abstract
An experiment was laid out to study the "Comparative evaluation of happy seeder technology with other sowing methods and weed management practices in linseed under rice - based cropping system in conservation agriculture" during *kharif* and *rabi* season of (2019-20 and 2020-21) at IGKV, Raipur, Chhattisgarh. The experiment was conducted in split plot design with three replications comprising three methods of sowing *viz*., T_1: zero seed drill, T_2: happy seed drill and T_3: normal seed drill (soil preparation only by rotavator) in main plot and three weed management practices *viz*., W_1: chemical weed control, W_2: hand weeding twice and W_3: unweeded check control in sub plot respectively. The results reveled that, among the methods of sowing all the growth parameters *i.e.* plant height, number of branches plant^{-1}, dry matter accumulation, yield attributes *viz*., number of capsules plant^{-1}, number of seeds capsule^{-1}and 1000seed weight (g) were significantly higher under T_2- happy seed drill followed by T_3-normal seed drill (soil preparation only by rotavator). The pooled data of seed and stover yield of linseed were also found maximum (1492 and 2991 kg ha^{-1}, respectively) when shown with happy seed drill, which was significantly higher in comparison to the sowing with normal seed drill (soil preparation only by rotavator) and zero seed drill.

Keywords: Happy seeder technology, weed management practices, agriculture, Chhattisgarh

Introduction
Rice based cropping system can be described as mix of farming practices that comprises of rice as the major crop followed by subsequent cultivation of other crops. Rice-based cropping systems have been reported from different parts of India ranging from rice-rice-rice to rice followed by different cereals, pulses, oilseeds, vegetables and fiber crops (Deep *et al.*, 2018) [6]. In Chhattisgarh, the existing practices of rice based rain-fed double crops are rice-gram, rice-lathyrus, rice-linseed, rice-pea, rice-lentil *etc*. In midland and lowland rice culture the next common practice is that the seed of succeeding crops like lentil, gram, pea, lathyrus, and linseed are broadcasted in standing rice crop at 25- 30 days before harvesting (*Utera* system). This practice saves time, money and utilizes residual fertility but their yield is very low. (Banjara *et al.*, 2017) [5].

Linseed or flax (*Linum usitatissimum* L.) is one of the oldest pulse crop grown in almost all countries of the world for oil, fiber and seed purposes. Linseed is unique among oilseeds for its technical grade vegetable oil producing ability and fiber (good quality having high strength and durability) production. It contains 35-45 % oil with high content of omega-3 fatty acid, alpha lenolenic acid (ALA).In India linseed crop occupies an area of 172.71 thousand ha, having an average production of 99.07 thousand tones and productivity 574 kg ha^{-1} (Anonymous, 2018) [3]. Chhattisgarh is one of the important linseeds growing states of India, where linseed is being cultivated over 17.76 thousand hectares with a production of 4.62 thousand tonnes and productivity 260 kg ha^{-1} (Anonymous, 2018) [3]. Linseed is mostly grown as *utera* (relay) during *Rabi* season (Agrawal *et al.*, 2014) [2].

Conventional agriculture system is an energy intensive farming system which involves excessive and inappropriate tillage operations with burning / removal of crop residue and poor nutrient replenishment through inadequate fertilizer use lead to soil erosion, depletion of organic matter, soil moisture and other nutrients which results to soil degradation and productivity losses (Sharma *et al.*, 2012) [9].

Therefore, there is a need for technologies which reduce energy, labour and water use, and environmental pollution, and which improve soil physical, chemical and biological properties. Potential solution includes a shift from conventional agriculture system to conservation agriculture (CA) system. The CA system is based on three linked principles-minimum soil disturbance, soil surface cover at all times with crop residues retention, and diversified crop rotation (Hobbs *et al.*, 2008) [7].

Weeds can be controlled by different methods such as manual, mechanical, and chemical methods. Generally, for the weed management, farmers do manual weeding, but manual weed management is always laborious, expensive, time consuming, uneconomical and needs to be often repeated at different intervals, as compared to chemical weed management. Weed management with herbicides is an effective, quick in action, and time saving (Ahmed *et al.*, 2005) [1]. Herbicide treatment gave 50 - 64% weed control with considerable increase in yield (Bhalla *et al.* 1998) [4]. Weedgrowth significantly reduced by the use of herbicides and resulted in 50% increase in yield over untreated fields (Hosseini *et al*. 1997) [8]. Timely weed management practices play an important role in the successful cultivation of the crop.

Material and methods

A field experiment was carried out during *kharif* and *rabi* season of (2019-20 and 2020-21) at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The soil of the experiment field was clay soil in texture, neutral in reaction, low in organic carbon, nitrogen and phosphorus and high in potassium contents. The experiment was conducted with the objective to determine the appropriate methods of sowing and weed management practices under direct seeded rice based cropping system. The experiment consisted were laid out rice-linseed cropping system. In *kharif* season rice variety: Rajeshwari was directly sown in the main field without any treatment adopted and only general package of practices were followed. In *Rabi* season linseed was grown in the four set of same layout in split plot design with three replications. Treatments comprised of three methods of sowing *viz*., T_1: zero seed drill, T_2: happy seed drill and T_3: normal seed drill (soil preparation only by rotavator) in main plot, three weed management practices *viz*., W_1: chemical weed control, W_2: hand weeding twice and W_3: unweeded check control in sub plot respectively. The growing variety for test crop was linseed: RLC-92: Indira Alsi. Observation on growth parameters *viz,*. plant height, number of primary branches, number of secondary branches and plant dry matter accumulation was recorded at harvest. Data on yield attributes *viz.*, number of capsules plant^{-1}, Number of seeds capsules^{-1}, Number of seeds plants^{-1} and 1000 seed weight (g)of linseed was observed atthe time of harvesting of the crop. seed from the net plot area were harvested separately and weighed for grain yield then stover was bundled and weighed plot wise.All data obtained from the experiment was statistically analyzed using *F*- test, critical difference (CD) values at *P*= 0.05 were used to determine the significance of mean differences of treatments.

Result and Discussion

Growth parameters

The data presented intable 1reveals that growth parameters of linseed increased progressively with the advancement of crop age till harvest. Among different methods of linseed sowing, significantly higher values of all growth parameters were recorded under T_2: happy seed drill as compare to other methods of sowing. While the lowest values were recorded under T_1: zero seed drill at all the growth stages during both the years and on mean basis.

Weed management practices had a significant effect on growth parameters mentioned above. W_2: hand weeding twice was resulted in maximum values of growth parameters at harvest during both the years and on mean basis, which was followed by W_1: chemical weed management. W_3: Un weeded control registered minimum values during both years and on mean basis.

Interaction effect due to different methods of sowing and weed management practices did not show significant effect on growth characters at harvest, during both the years as well as their mean.

Yield attributing characters

These parameters was influenced significantly due to methods of sowing and weed management practices under direct seeded rice during 2019-20 and 2020-21 as well as in mean data basis (Table 2).

Significantly higher number of capsules plant^{-1} were obtained under T_2: happy seed drill (Mean *viz.*, 50.14), but it was followed by T_3: normal seed drill (soil preparation only by rotavator) (Mean *viz.*, 39.64) and T_1: zero seed drill (Mean *viz.*, 27.91) during both years and on mean value. Among weed management practices significantly higher number of capsules plant^{-1} was observed with W_2: hand weeding twice (Mean *viz.*, 44.45) compared to other treatment during both years as well as mean data. W_3: Unweeded control produced the lowest number of capsules plant^{-1} during both years of experiment and mean value. Interaction of T_2: happy seed drill with W_2: hand weeding twice produced maximum number of capsules plant^{-1}, while the interaction between T_1: zero seed drill with W_3: unweeded check produced the lowest number of capsules plant^{-1} during both years of investigation and on mean value.

Number of seeds capsules^{-1} did not significantly influenced by the methods of sowing and weed management practices during both years as well as their mean. However, the highest number of seeds capsules^{-1} (Mean *viz.*, 7.54) was recorded by plot sown by T_2: happy seed drill which was succeeded by sowing done with T_3: normal seed drill (soil preparation only by rotavator) (Mean *viz.*, 6.92) and T_1: zero seed drill (Mean *viz.*, 6.37)during both years of testing and mean value. Among weed management practices the highest number of seeds capsules^{-1}was noted during both years of testing and their mean under T_2: hand weeding twice (Mean *viz.*, 7.03), which was found to be more effective in obtaining higher number of seeds capsules^{-1} as compare to W_1: chemical weed management (Mean *viz.*, 6.86) and W_3: unweeded check control (Mean *viz.*, 6.94).Interaction effect of methods of sowing and weed management of linseed did not found to be significantly affecting the number of seeds capsules^{-1}during 2019-20 and 2020-21 including their mean.

The number of seeds plants^{-1} was significantly influenced by the methods of sowing and weed management practices during both years of experiment and mean data. As regard to methods of sowing T_2: happy seed drill gave significantly higher number of seeds plant^{-1}(376.81 and 379.81) as

compare to other methods of sowing during 2019-20 and 2020-21. The mean data of number of seeds plant^{-1} (378.31) was also highest under the T_2: happy seed drill. The minimum number of seeds plant^{-1} (Mean *viz.*, 177.96) was found under the T_1: zero seed drill during both the years of experiment and their mean.As regards to weed management practices W_2: hand weeding twice produced significantly higher number of seeds plant^{-1} (312.35 and 321.11), which was followed by W_1: chemical weed management (272.29 and 283.47), during 2019-2020 and 2020-2021. Similarly mean data also showed that T_2: hand weeding twice is more superior in giving higher number of seed plant^{-1} as compare to other weed management practices. Significantly least number of seed plant^{-1} (232.71and 238.35) was obtained under W_3: unweeded check control during 2019-2020 and 2020-2021, respectively including mean data (235.53).Interaction of methods of sowing and weed management on number of seeds plant^{-1} during both years including their mean was found to be significant. Interaction effect between T_2: happy seed drill with W_2: hand weeding twice obtained maximum number of seeds plant$^{-1.}$ On the other hand, interaction between T_1: zero seed drill with W_3: UN weeded control check obtained minimum number of seeds plant^{-1} during both years of experiment as well as on their mean basis.

The presented data of 1000 seed weight (g) was statistically non-significant during both the years of investigation as well as their mean due to sowing methods, weed management practices and their interactions. Among methods of sowing the highest 1000 seed weight (g) was recorded under T_2: happy seed drill (6.23 and 6.28 g), however it was found to be superior over T_3: normal seed drill (soil preparation only by rotavator) (6.22 and 6.24 g) and T_1: zero seed drill (6.05 and 6.18 g), which produced the minimum number of 1000 seed weight (g) during 2019-20 and 2020-21, respectively. The mean data of 1000 seed weight (g) was also maximum when shown under happy seed drill. In regards to weed management practices, W_2: hand weeding twice resulted in maximum 1000 seed weight (6.23 and 6.29 g) in the years 2019-20 and 2020-21, respectively which was statistically at par with W_1: chemical weed management and W_3: unweeded check control.

Yields of linseed

Data regarding seed yield and stover yield of linseed significantly influenced by methods of sowing and weed management practices data during data of two years and mean value (Table 3). The yields were comparatively higher in 2020-21 than in 2019-20. Although same cultivar 'RLC-92: Indira Alsi' was sown the almost at the same time and similar management practices were followed in the both years, the crop performance varied due to improved soil health and microclimatic conditions in subsequent year.

Among methods of sowing, the highest seed and stover yield of linseed was recorded under T_2: happy seed drill (Mean *viz.*, 1470.46kg ha^{-1} and 2990.80kg ha^{-1}, respectively). This treatment produced maximum seed and stover yield to that of T_3: normal seed drill (soil preparation only by rotavator) (Mean *viz.*, 1162.99kg ha^{-1} and 2483.46kg ha^{-1}, respectively) during both the years of investigation and on their mean basis. The lowest seed and stover yield was recorded under T_1: zero seed drill (Mean *viz.*, 860.14kg ha^{-1} and 1877.44kg ha^{-1}, respectively) during both the years and on mean basis.

The data of weed management practices revealed that the highest seed and stover yield of linseed (Mean *viz.*, 1340.41kg ha^{-1} and 2682.29kg ha^{-1}, respectively) was observed under W_2: hand weeding twice, which was followed by W_1: chemical weed management (Mean *viz.*, 1192.65kg ha^{-1} and 2481.07kg ha^{-1}, respectively). The lowest seed and stover yield (Mean *viz.*, 960.53kg ha^{-1} and 2188.33kg ha^{-1}, respectively) was recorded under W_3: UN weeded check control during both years and on mean data basis.

The interaction effect between methods of sowing and weed management practices with respect to seed and stover yield of linseed was found significant during both the years and on their mean. Among various interaction effects, T_2: happy seed drill along with W_2: hand weeding reported to be significantly superior over rest of the interactions in increasing the seed and stover yield of linseed during both year of experiment and on their mean. However, the lowest seed and stover yield were reported under T_1: zero seed drill with W_3: un weeded check during both years of investigation and on mean basis.

It is clear from consideration of two years data and mean value, harvesting index (%) of linseed significantly influenced by the methods of sowing and weed management practices. As regards to the different methods of sowing the highest harvest index (%) was observed under sowing done with T_2: happy seed drill (Mean *viz.*, 32.89%), which is superior over T_3: normal seed drill (soil preparation only by rotavator) (Mean *viz.*, 31.85 %).Whereas the minimum harvest index was found under T_1: zero seed drill (Mean *viz.*, 30.93 %) during both the years and on their mean. The data of weed management practices indicated that W_2: hand weeding twice, gave the highest harvest index (Mean *viz.*, 33.22%) of linseed, which was followed by W_1: chemical weed management (Mean *viz.*, 32.46%) during both the years and on mean basis. The minimum harvest index (Mean *viz.*, 29.98 %) on the other hand was observed under W_3: UN weeded check control during both the years and on mean basis.

Table 1: Growth attributes of linseed as influenced by different sowing methods and weed management practices under direct seeded rice based cropping system

Treatment	Plant height (cm)			Number of primary branches plant^{-1}			Number of secondary branches plant^{-1}			Plant dry matter accumulation (g m^{-2})		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing												
T_1: Zero seed drill	66.46	74.06	70.26	4.42	4.53	4.48	16.70	17.55	17.12	806.04	826.15	816.10
T_2: Happy seed drill	75.68	82.06	78.87	5.10	5.26	5.18	18.33	18.67	18.50	852.10	879.60	865.85
T_3: Normal seed drill (soil preparation only by rotavator)	71.64	78.37	75.01	4.80	4.86	4.83	17.68	18.41	18.04	827.03	853.58	840.30
Sem±	0.70	0.58	0.64	0.12	0.10	0.10	0.12	0.11	0.05	1.54	1.17	1.25
CD (P=0.05)	2.76	2.26	2.51	0.49	0.41	0.38	0.46	0.45	0.20	6.06	4.58	4.91

Sub plot- Weed management												
W_1: Chemical weed control	72.20	78.53	75.37	4.74	4.95	4.84	17.64	18.22	17.93	829.35	854.83	842.09
W_2: Hand weeding twice	76.79	81.93	79.36	5.16	5.11	5.14	18.72	19.19	18.95	860.68	881.30	870.99
W_3: Unweeded check control	64.78	74.04	69.41	4.42	4.60	4.51	16.35	17.21	16.78	795.14	823.21	809.18
SEm±	0.55	0.52	0.36	0.13	0.12	0.09	0.13	0.10	0.07	2.87	2.80	2.01
CD (P=0.05)	1.69	1.60	1.10	0.41	0.38	0.29	0.41	0.31	0.23	8.84	8.63	6.18
Interaction (T X W)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield attributes of linseed as influenced by different sowing methods and weed management practices under direct seeded rice based cropping system

Treatment	Number of capsules plant^{-1}			Number of seeds capsule^{-1}			Number of seeds plant^{-1}			1000 seed weight (g)		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing												
T_1: Zero seed drill	26.99	28.83	27.91	6.32	6.42	6.37	170.75	185.16	177.96	6.05	6.18	6.12
T_2: Happy seed drill	50.05	50.22	50.14	7.53	7.56	7.54	376.81	379.81	378.31	6.23	6.28	6.26
T_3: Normal seed drill (soil preparation only by rotavator)	39.19	40.08	39.64	6.90	6.94	6.92	269.79	277.95	273.87	6.22	6.24	6.23
Sem±	0.47	0.46	0.37	0.25	0.26	0.09	9.15	11.10	4.85	0.08	0.06	0.03
CD (P=0.05)	1.85	1.81	1.47	NS	NS	NS	35.93	43.59	19.03	NS	NS	NS
Sub plot- Weed management												
W_1: Chemical weed control	39.62	40.49	40.06	6.78	6.93	6.86	272.29	283.47	277.88	6.20	6.23	6.21
W_2: Hand weeding twice	43.85	45.05	44.45	7.03	7.04	7.03	312.35	321.11	316.73	6.23	6.29	6.26
W_3: Unweeded check control	32.76	33.59	33.17	6.93	6.95	6.94	232.71	238.35	235.53	6.08	6.19	6.13
SEm±	0.47	0.67	0.38	0.15	0.15	0.09	7.21	6.12	4.18	0.06	0.04	0.05
CD (P=0.05)	1.43	2.07	1.16	NS	NS	NS	22.23	18.87	12.88	NS	NS	NS
Interaction (T X W)	S	S	S	NS	NS	NS	S	S	S	NS	NS	NS

Table 3: Yields of linseed as influenced by different methods of sowing and weed management under direct seeded rice based cropping system

Treatment	Seed yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Harvest index (%)		
	19-20	20-21	Mean	19-20	20-21	Mean	19-20	20-21	Mean
Main plot- Methods of sowing									
T_1: Zero seed drill	852	913	883	1876	1879	1877	30.82	31.04	30.93
T_2: Happy seed drill	1458	1526	1492	2971	3011	2991	32.85	32.93	32.89
T_3: Normal seed drill (soil preparation only by rotavator)	1144	1227	1185	2443	2523	2483	31.84	31.85	31.85
SEm±	14.64	14.58	9.88	21.32	21.24	11.35	0.34	0.19	0.22
CD (P=0.05)	57.50	57.23	38.79	83.70	83.41	44.56	1.32	0.73	0.88
Sub plot- Weed management									
W_1: Chemical weed control	1180	1250	1215	2450	2512	2481	32.40	32.52	32.46
W_2: Hand weeding twice	1329	1395	1362	2673	2691	2682	33.13	33.31	33.22
W_3: Unweeded check control	945	1021	983	2167	2210	2188	29.96	30.00	29.98
SEm±	17.48	25.14	15.53	24.51	16.77	11.36	0.32	0.48	0.29
CD (P=0.05)	53.87	77.47	47.84	75.51	51.66	35.01	0.98	1.47	0.89
Interaction (T X W)	S	S	S	S	S	S	S	S	S

Conclusion

Growth attributes, yield attributes, grain yield and stover yield of linseed were significantly higher when shown with happy seed drill followed by showing with normal seed drill. However, zero seed drill sowing of crop failed to improve the production of linseed in comparison to other sowing methods. Amongst weed management practices, weed management through hand weeding twice proved best with respect to growth attributes, yield attributes, grain yield and stover yield of linseed followed by weed management through using chemicals. From two year experimentation it can be concluded that for better productivity and profitability of linseed, it can be shown using happy seed drill along with managing the weeds by hand weeding twice within the critical period for crop-weed competition.

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