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AGRONOMY

Effect of Sowing Methods and Seed Rates on Phenological, Physiological and Yield Parameters of Chandrasur (*Lepidium sativum* L.)

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ABSTRACT

The present experiment was conducted in the department of Plantation, Spice, Medicinal and Aromatic Crops, College of Horticulture, RVSKVV, Mandsaur (M.P.) during 2019-20 in factorial RBD design with replicated thrice with two sowing methods and five seed rates as treatments. All the parameters were recorded at a fixed interval of 30 days from 30 days after sowing to harvest. The results revealed that line sowing exhibited early germination, flowering, maturity, and higher leaf area, leaf area index, crop growth rate, relative growth rate, chlorophyll content, and seed yield compared to broadcast. Among the seed rates, medium seed rate @8 kg ha^{-1} is shown early in all the phenological and superior in physiological parameters. During interactions, line sowing with @ 8 kg seed ha^{-1} was also early in germination, flowering, maturity, leaf area, leaf area index, crop growth rate, relative growth rate, chlorophyll content, and seed yield. On the other hand, the maximum harvest index was noted in the broadcast with 12 kg seed rate.

HIGHLIGHTS

- Optimum spacing can ensure proper growth and development through efficient utilization of sources.
- Seed rate avoids wastage of valuable seeds.
- Line sowing with lower seed rate provides non-competitive space between the plants.
- Line sowing with @ 8 kg seed rate per hectare had the best performance for growth and yield.

Keywords: *Lepidium sativum*, Seed rates, Sowing methods, Phenology, and Physiology

Chandrasur (*Lepidium sativum* L.), coming to the family Cruciferae is an edible, annual, and erect herb called 'water cress' or 'common cress' or 'pepper cress. Its seeds, leaves, and roots are economic (Priya *et al.* 2018). If is beneficial in promoting digestion and growth in teenagers. The extracts of seed have a hypotensive effect with transient respiratory stimulation (Saraswathi *et al.* 2014). As a result of differentiated uses, Its demand, popularity, and cultivation is increasing en route for commercial production (Chundawat *et al.* 2017). It is grown mostly in India, North America, and some

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parts of Europe. In India, it is grown mainly in Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra, and Tamil Nadu for seeds. Optimum spacing can ensure proper growth and development through efficient utilization of solar radiation, nutrients, water, land, and air and intercultural operations (Meena *et al.* 2014). Seed rate is one of the main factors that has a vital role on the plant's growth, yield, and quality. This avoids the wastage of valuable seeds and unnecessary competition (Tiwari *et al.* 2002). But in India, most farmers follow broadcast or line sowing methods without maintaining proper spacing for growing chandrasur (Meena *et al.* 2017). Most of the farmers of Madhya Pradesh are sown chandrasur as broadcasting. So, there is an urgent need to develop agronomical practices such as seed rate, sowing time, plant geometry, and method of sowing, etc. for obtain good yield and to provide information to farmers for its production technology (Chundawat *et al.* 2017)

MATERIALS AND METHODS

The field experiment was led in the department of Plantation, Spice, Medicinal and Aromatic Crops, College of Horticulture Mandsaur, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during 2019-20 under factorial RBD design with replicated thrice. The experimental site is situated in the Malwa plateau in the Western part of Madhya Pradesh at 23.450 to 24.130 North latitudes, 74.440 to 75.180 East longitudes. It belongs to sub-tropical and semi-arid climatic conditions. The treatments were accompanied by two sowing methods (M_1-line sowing and M_2 -broadcasting) as main plots and five seed rates (S_1-4, S_2-6, S_3-8, S_4-10, and S_5-12 kg ha^{-1}) as sub-plots. All the parameters were recorded at 30, 60, 90 days after sowing and at harvest. The experimental data were subjected to statistical analysis using the technique suggested by Panse and Sukhatme (1985). The "F" test was found significant at 5 %, and the critical differences for the treatment's comparison were worked out. In each plot, observation recorded that from sowing to 50% of seedlings come from the soil, plants attained 50% flowering, and for maturity when more than 90 percent of plants turned yellowish and attained maturity from date of sowing for phenological parameters. The leaf area was recorded using a laser area meter (Model LI-300), and the leaf area index was worked out as per the specifications of Gardner *et al.* (1985). The CGR and the RGR were determined as per the formula suggested by Watson (1952).

RESULTS AND DISCUSSION

Phenological Parameter: All the phonological data were significantly influenced by the applied sowing methods and seed rate during an investigation and are presented in Table 1.

Effect of sowing methods

Results revealed that line sowing showed early 50% germination (4.47 days), 50% flowering (60.00 days), and maturity (118.27 days) followed by broadcasting which was late in the same trails, but both the sowing methods were at par with each other. Probably because of sufficient space for germination and other phenophases that prevailed during broadcasting. The early phenophases may be due to the optimum plant spacing. Similar results were found by Meena *et al.* (2017) in chandrasur and Giridhar *et al.* (2017) in nigella.

Effect of seed rates

However, among the seed rates, 8 kg seed was found to have a significant earliest 50% germination (4.17 days), 50% flowering (59.00 days), and maturity (117.17 days), which was at par with 6 kg seed rate but significantly superior over rest of the seed rates. Optimum plant spacing could possibly be the reason for the early phenology during medium seed rate. Similarly, results were observed by Mengistu and Yamoah (2010) and Jawad *et al.* (2015).

Interactions effect

Line sowing with 8 kg seed was early in 50% germination (4.00 days), 50% flowering (58.00 days), and maturity (116.00 days). Thought line sowing with 6 kg seed rate lagged behind the former and at par in broadcast with 10 kg seed rate but significantly lower with the remaining interactions. There is less competition for sunlight, space, moisture, and nutrients during wider spacing which ultimately results in early phenophases, according to Angassa (2017) and Nayma *et al.* (2019) in chandrasur.

Table 1: Effect of sowing methods and seed rates on the phenological and yield parameters of *Lepidium sativum* during *rabi* 2019-20

Treatments	Phenological Parameters (No. of Days)			Yield Attributes	
	50% germination	50% flowering	Maturity	Seed yield (g plant^{-1})	Harvest Index (%)
Sowing methods					
M_1-Line sowing	4.47	60.00	118.27	18.95	46.64
M_2-Broadcast	4.60	60.53	118.80	18.76	47.26
S. Em.±	0.12	0.07	0.08	0.01	0.31
CD@ 5%	0.35	0.20	0.23	0.02	0.92
Seed rates (kg ha^{-1})					
S_1-4 kg	4.67	60.67	119.50	18.51	58.52
S_2-6 kg	4.33	60.00	117.67	19.16	36.02
S_3-8 kg	4.17	59.00	117.17	19.36	34.99
S_4-10 kg	4.50	60.17	118.17	18.94	41.40
S_5-12 kg	5.00	61.50	120.17	18.30	63.84
S. Em.±	0.19	0.10	0.12	0.01	0.49
CD@ 5%	0.55	0.31	0.36	0.03	1.46
Interactions (sowing method × seed rate)					
$M_1 \times S_1$	4.67	60.67	119.33	18.53	58.39
$M_1 \times S_2$	4.00	59.67	117.00	19.56	34.16
$M_1 \times S_3$	4.00	58.00	116.00	19.67	32.44
$M_1 \times S_4$	4.67	60.33	119.00	18.62	46.37
$M_1 \times S_5$	5.00	61.33	120.00	18.38	61.84
$M_2 \times S_1$	4.67	60.67	119.67	18.48	58.65
$M_2 \times S_2$	4.67	60.33	118.33	18.77	37.88
$M_2 \times S_3$	4.33	60.00	118.33	19.05	37.54
$M_2 \times S_4$	4.33	60.00	117.33	19.27	36.42
$M_2 \times S_5$	5.00	61.67	120.33	18.23	65.83
S. Em.±	0.26	0.15	0.17	0.01	0.70
CD@ 5%	0.78	0.44	0.51	0.04	2.07

Physiological Parameters: The investigation pertaining that the physiological parameters varied significantly with different sowing methods and seed rates during the whole life span and data are presented in Table 2.

Effect of sowing methods

The result confirms that the line sowing accumulated higher leaf area (119.50, 393.94, 669.84, and 668.14), leaf area index (0.856, 1.773, and 2.230), crop growth rate (0.152, 0.131 and 0.184), relative growth rate (0.0872, 0.0820 and 0.0930) and chlorophyll content (42.59, 44.56 and 47.42) as compared to broadcast which was lowest in the same trait at 30, 60, 90 DAS and at harvest, respectively. Increased leaf area and their related growth parameters resulted in a greater light interception in line sowing by the crop, which might have contributed to the vegetative growth of plants. Similar findings agreed with the results of Priya *et al.* (2018) in Chandrasur.

Effect of seed rates

8 kg seed rate had recorded the maximum leaf area (120.44, 397.00, 674.18, and 672.29), leaf area index (0.862, 1.785 and 2.244), crop growth rate (0.161, 0.141, and 0.194), relative growth rate (0.0890, 0.0850 and 0.0950) and chlorophyll content (42.94, 45.67 and 48.12) followed by 6 kg seed rate and were differed with each other but significantly higher over rest of the seed rates at 30, 60, 90 DAS and at harvest, respectively. The higher crop growth might be due to broader spacing in low seed rate; hence more production of photosynthates in the leaves was rapidly consumed by the plant in all the phases. This is similar to the results of Priya *et al.* (2018) in Chandrasur and Khoja (2004) in Coriander.

Interaction effect

The statistical data showed that line sowing with 8 kg seed had shown significant superiority for leaf

Table 2: Effect of sowing methods and seed rates on the leaf area and chlorophyll content of *Lepidium sativum* during *rabi* 2019-20

Treatments	Leaf area (cm^2 $plant^{-1}$)				Chlorophyll contents (SPAD)		
Sowing methods	**30 DAS**	**60 DAS**	**90 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**90 DAS**
M_1-Line sowing	119.50	393.94	669.84	668.14	42.59	44.56	47.42
M_2-Broadcast	119.33	393.39	668.75	667.20	42.30	44.37	47.17
S. Em.±	0.010	0.016	0.015	0.059	0.012	0.014	0.006
CD@ 5%	0.030	0.048	0.046	0.175	0.036	0.041	0.018
Seed rates (kg ha^{-1})							
S_1-4 kg	118.64	390.26	666.01	665.30	42.06	43.78	46.63
S_2-6 kg	120.26	395.92	672.74	670.72	42.81	45.01	47.89
S_3-8 kg	120.44	397.00	674.18	672.29	42.94	45.67	48.12
S_4-10 kg	119.80	395.64	671.75	669.21	42.54	44.63	47.59
S_5-12 kg	117.95	389.50	661.79	660.83	41.88	43.23	46.23
S. Em.±	0.016	0.026	0.024	0.093	0.019	0.022	0.009
CD@ 5%	0.047	0.076	0.072	0.277	0.057	0.065	0.028
Interactions (sowing method × seed rate)							
$M_1 \times S_1$	118.67	390.66	666.38	665.68	42.10	43.90	46.67
$M_1 \times S_2$	120.69	397.03	674.97	672.55	43.26	45.18	48.20
$M_1 \times S_3$	120.82	397.58	675.07	672.93	43.31	46.29	48.51
$M_1 \times S_4$	118.95	394.74	669.15	666.10	42.33	44.20	47.15
$M_1 \times S_5$	118.39	389.67	663.63	663.42	41.95	43.25	46.56
$M_2 \times S_1$	118.62	389.86	665.64	664.92	42.01	43.67	46.59
$M_2 \times S_2$	119.83	394.80	670.50	668.88	42.36	44.83	47.58
$M_2 \times S_3$	120.06	396.43	673.30	671.65	42.56	45.05	47.73
$M_2 \times S_4$	120.66	396.54	674.36	672.32	42.75	45.07	48.04
$M_2 \times S_5$	117.51	389.33	659.95	658.24	41.81	43.21	45.90
S. Em.±	0.022	0.036	0.035	0.132	0.027	0.031	0.013
CD@ 5%	0.066	0.108	0.102	0.392	0.081	0.092	0.039

area (120.82, 397.58, 657.07 and 672.93), leaf area index (0.864, 1.788 and 2.247), crop growth rate (0.162, 0.147 and 0.206), relative growth rate (0.0893, 0.0861 and 0.0970) and chlorophyll content (43.31, 46.29 and 48.51) among the interactions. Though, line sowing with 6 kg seed rate lagged behind the former but was significantly superior over the rest of the interactions at 30, 60, 90 DAS, and at harvest, respectively. It is observed that the relative growth rate was slow with the advancement of growth stages, especially 60 days after sowing. It may be due to the natural senescence of older leaves. However, a higher growth rate was observed in line with sowing with a low seed rate. Wider spacing had optimum spacing, light moisture provided to plants, and production of more photosynthates resulting in a higher relative growth rate. Similar findings were found by Priya *et al.* (2018) in Chandrasur and Lavanya *et al.* (2014) in radish.

Seed Yield and their Components: The seed yield was significantly influenced with higher spacing and medium seed rates of chandrasur and are presented in Table 3.

Effect of sowing methods

It is confirmed from the results that the line sowing had a higher seed yield (18.95 g $palnt^{-1}$) as compared to broadcast, which was lowest in the same trait. But the more harvest index was noted in broadcast (47.26 %) over line sowing. The higher seed yield was due to more photosynthetic leaf area, and its efficient utilization from source to sink might have increased the better filling of seeds the pods, thus leading to increased seed yield. These results are in agreement with the report of Bilekudari *et al.* (2005).

Effect of seed rates

8 kg rate produced (19.36 g $plant^{-1}$) seeds which were highest among the other seed rates. Though, 6 kg seed rate lagged behind the former over the remaining seed rates. But again, the higher harvest index (63.54 %) in the 12 kg seed rate over the rest of

Table 3: Effect of sowing methods and seed rates on the leaf area index, crop growth rate and relative growth rate of *Lepidium sativum* during *rabi* 2019-20.

Treatments	Leaf area index			Crop growth rate (g cm^{-2} $days^{-1}$)			Relative growth rate (g g^{-1} day^{-1})		
Sowing methods	30 -60 DAS	60 -90 DAS	90 - At harvest	30 -60 DAS	60 -90 DAS	90 - At harvest	30 -60 DAS	60 -90 DAS	90 DAS - At harvest
M_1-Line sowing	0.856	1.773	2.230	0.152	0.131	0.184	0.0872	0.0820	0.0930
M_2-Broadcast	0.855	1.770	2.226	0.152	0.125	0.177	0.0870	0.0810	0.0920
S. Em.±	0.003	0.004	0.010	0.013	0.015	0.012	0.003	0.004	0.002
CD@ 5%	0.010	0.012	0.031	0.039	0.045	0.035	0.008	0.012	0.010
Seed rates (kg ha^{-1})									
S_1-4 kg	0.848	1.760	2.219	0.145	0.118	0.172	0.0856	0.0790	0.0910
S_2-6 kg	0.860	1.781	2.238	0.158	0.137	0.187	0.0886	0.0840	0.0940
S_3-8 kg	0.862	1.785	2.244	0.161	0.141	0.194	0.0890	0.0850	0.0950
S_4-10 kg	0.859	1.779	2.236	0.156	0.133	0.181	0.0881	0.0830	0.0930
S_5-12 kg	0.846	1.753	2.204	0.140	0.111	0.170	0.0844	0.0760	0.0910
S. Em.±	0.005	0.006	0.017	0.021	0.024	0.019	0.004	0.006	0.004
CD@ 5%	0.016	0.018	0.049	0.062	0.072	0.055	0.013	0.019	0.012
Interactions (sowing method × seed rate)									
$M_1 \times S_1$	0.848	1.762	2.220	0.146	0.125	0.172	0.0858	0.0806	0.0910
$M_1 \times S_2$	0.863	1.787	2.246	0.161	0.144	0.198	0.0892	0.0855	0.0960
$M_1 \times S_3$	0.864	1.788	2.247	0.162	0.147	0.206	0.0893	0.0861	0.0970
$M_1 \times S_4$	0.856	1.773	2.228	0.153	0.125	0.174	0.0875	0.0807	0.0920
$M_1 \times S_5$	0.848	1.756	2.212	0.140	0.115	0.170	0.0844	0.0771	0.0910
$M_2 \times S_1$	0.848	1.758	2.218	0.144	0.112	0.171	0.0854	0.0779	0.0910
$M_2 \times S_2$	0.858	1.775	2.230	0.155	0.130	0.177	0.0880	0.0819	0.0920
$M_2 \times S_3$	0.861	1.783	2.242	0.159	0.134	0.182	0.0887	0.0830	0.0930
$M_2 \times S_4$	0.862	1.785	2.244	0.159	0.141	0.187	0.0888	0.0846	0.0940
$M_2 \times S_5$	0.845	1.750	2.197	0.139	0.107	0.169	0.0843	0.0754	0.0910
S. Em.±	0.008	0.009	0.023	0.029	0.034	0.026	0.006	0.009	0.005
CD@ 5%	0.022	0.026	0.070	0.087	0.102	0.078	0.019	0.026	0.015

the seed rates. The beneficial effect of less seed rate in seed yield has been due to better light penetration and higher photosynthetic efficiency resulting in the development of plant canopy with more pods/plant and seed/pods as early reported by Shambhu *et al.* (2019) in chandrasur.

Interaction effect

Line sowing with 8 kg seed rate produced higher seed (19.67 g $plant^{-1}$). Though, line sowing with 6 kg seed rate lagged behind the former but was significantly superior over the rest of the interactions. On the other hand, the maximum harvest index (65.83 %) was noted in the broadcast with 12 kg seed rate. Line sowing with lower seed rate provide non-competitive space between the plants as higher plant density adversely affect the growth and development. On othe other hands, a higher yield per plant was obtained under wider spacing with low seed rates Chundawat *et al.* (2017) in Chandrasur. These findings are in agreed with the results of Meena *et al.* (2017) and Nayma et al. (2019) in Chandrasur.

CONCLUSION

Based on our findings, it can be concluded that line sowing with @ 8 kg seed rate per hectare had the best performance for chandrasur growth and yield and could be recommended to farmers for the cultivation of chandrasur.

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