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Effect of integrated nutrient management and irrigation on growth parameters and yield of chandrasur (*Lepidium sativum* L.) under different moisture conservation practices

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Abstract
A field experiment was conducted during rabi season of 2015-16 and 2016-17 at Soil Conservation and Water Management Farm of C.S.A.U.A & T., Kanpur to study the effect of integrated nutrient management and irrigation on growth parameters and yield of chandrasur (Lepidium sativum L.) under different moisture conservation practices. The result revealed that growth attributes viz., plant height, number of branches plant^{-1}, fresh and dry weight plant^{-1} and days to flowering and yield viz., seed, stover, biological, oil yield and harvest index of chandrasur was significantly increased with irrigation applied at 35 and 70 days after sowing as compared to irrigation given at 35 and 60 days after sowing and irrigation applied at 35 days after sowing during both the years of study. Application of 75% N through fertilizer + 25% N through vermicompost + PSB produced significantly highest all growth attributes and yield of chandrasur than the application 75% N through fertilizer + 25% N through FYM and 100% N through fertilizer in the respective years of study. Among the different moisture conservation practices, significantly higher growth parameters viz., plant height, number of branches plant^{-1}, fresh and dry weight plant^{-1} and days to flowering and yields viz., seed, stover, biological, oil yield and harvest index of chandrasur produced significantly higher with weeding and hoeing + organic residue mulch @ 4 t ha^{-1} than organic residue mulch @ 4 t ha^{-1} and control during 2015-16 and 2016-17.

Keywords: Chandrasur (garden cress), integrated nutrient management, moisture conservation, biological yield, growth parameters

1. Introduction
Chandrasur (*Lepidium sativum* L.) is commonly known as garden cress is belonging to the Brassicaceae family. Garden cress is also widely cultivated in temperate countries for various culinary and medicinal purposes. In India, it is mainly grown in Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujarat and Maharashtra. It is available in almost all parts of the world. Nutritive value of these leaves and seeds is very high. The seeds are strong antioxidant. They have anti-diabetic, cholesterol lowering, blood pressure lowering, anti-spasmodic, liver protective, antipyretic and it has good anti cancer property. The seeds are known to contain a light yellow coloured fixed oil and alkaloids such as lepidin, glucotropaeolin, besides sinapin and sinapic acid. The seeds are good source to enhance the milk percentage in cattle as well as in nursing mother. They are mainly used in Ayurveda, Unani and Siddha system of medicine used as thermogenic, depurative, galactogouge, tonic, aphthalmic, antiscorbutic, antiasthamatic, diuretic etc. Fresh leaves and young seedlings are mainly used as spice and are rich source of glucosinolates and also used as salad. Root are bitter, acrid and are useful in treatment of secondary syphilis. Irrigation scheduling, integrated nutrient management and moisture conservation are the important facters which can limit crop growth, production and yield. The facters like growth, dry matter accumulation, seed and oil yield are all dependent on optimum integrated nutrient management, irrigation and moisture conservation practices and very little research work has been done out on such an important medicinal crop, garden cress. Considering the above facts, the present investigation was undertaken to study the irrigation scheduling, integrated nutrient management and moisture conservation practices of garden cress.

2. Materials and methods
A field experiment was conducted during two consecutive years of 2015-16 and 2016-17 to study the effect of integrated nutrient management and irrigation on growth parameters and yield of garden cress (*Lepidium sativum* L.) under different moisture conservation practices at

Soil Conservation and Water Management Farm of C.S.A.U.A& T., Kanpur. Geographically Kanpur is located of 26.30° N Longitude of 80.15° E and above 125.9 meters above mean sea level. The treatment combination consisting three irrigation scheduling viz., irrigation given at 35 DAS, at 35 and 60 DAS and at 35 and 70 DAS, three level of integrated nutrient management viz., 100% N (60 kg ha^{-1}) through fertilizer, 75% N through fertilizer + 25% N through FYM and 75% N through fertilizer + 25% N through vermicompost + PSB and three moisture conservation practices viz., control, organic residue mulch @ 4 t ha^{-1} and weeding and hoeing + organic residue mulch @ 4 t ha^{-1}. The experiment was laid out in split plot design with three replications with irrigation scheduling in main plots, integrated nutrient management in sub plots and moisture conservation practices in sub-sub plots. The seed of chandrasur @ 4 kg ha^{-1} was sown in furrow by desi plough keeping row to row distance of 30 cm and plant to plant 15 cm. The crop of chandrasur was sown on 19.11.2015 and 25.11.2016 and harvest was done on 02.04.2016 and 06.04.2017 during first and second year of experimentation. The crop of chandrasur was fertilized as per treatment requirement with 60 kg N + 30 kg P_2O_5 + 30 kg K_2O ha^{-1}. The half dose of nitrogen and full dose of phosphorus and potash was applied at the time of sowing, remaining half dose of nitrogen was top dressed after 1st irrigation. The nitrogen was applied as a organic and inorganic sources as per treatments. The winter rainfall was received 49.9 and 32.8 mm in 2015-16 and 2016-17, respectively. The collected data on growth parameters and yield was subjected to statistical analysis using the Fischer's method of analysis variance technique as given by Panse and Sukhatme (1967) [2]. For estimation of oil content, 100 (g) of seeds were taken from each plot and were uniformly dried and analyzed using NMR spectroscopy and was expressed as percentage.

3. Results and discussion

3.1 Growth parameters

Data pertaining to growth parameters viz., plant height (cm), number of branches $plant^{-1}$, fresh and dry weight $plant^{-1}$ and days to flowering at harvest of chandrasur as influenced by different irrigation scheduling, integrated nutrient management and moisture conservation practices during 2015-16 and 2016-17 have been presented in Table (1).

Growth parameters viz., plant height (113.56 and 116.77 cm), number of branches $plant^{-1}$ (25.51 and 26.55), fresh weight (398.74 and 416.16 g) and dry weight $plant^{-1}$ (103.01 and 106.43 g)and days to flowering (85.25 and 87.57 days) produced significantly highest in irrigation given at 35 and 70 days after sowing as compared to irrigation given at 35 and 60 days after sowing and irrigation given at 35 days after sowing during 2015-16 and 2016-17, respectively. Irrigation given at 35 and 60 days after sowing also produced significantly more all growth parameters of chandrasur than irrigation given at 35 days after sowing during both the years of study. Minimum all growth parameters was produced with irrigation given at 35 days after sowing during both the years of investigation. The increase in growth parameters of chandrasur with increase in moisture availability throughout the growth period. Similar results have also been reported by Patnaik *et al.* (2016) [3] and Kumari and Patel (2013) [1].

Application of 75% N through fertilizer + 25% N through vermicompost + PSB produced significantly highest growth parameters viz., plant height (111.51 and 115.12 cm), number of branches $plant^{-1}$ (25.01 and 26.28), fresh weight (389.88 and 400.63 g) and dry weight $plant^{-1}$ (99.49 and 103.68 g) and days to flowering (84.15 and 88.26 days) as compared to 75% N through fertilizer + 25% N through FYM and 100% N through fertilizer in the respective years of study. Significantly more growth parameters of chandrasur was produced with the application 75% N through fertilizer + 25% N through FYM than 100% N through fertilizer during both the years. Minimum all growth parameters at harvest of chandrasur was produced with the application of 100% N through fertilizer during 2015-16 and 2016-17. This could be attributed to the enhanced availability of fertilizers at the appropriate time along with congenial climate conditions, which might have resulted in increased photosynthetic rate and accumulation of metabolites in plant. Similar results are in agreement with the findings of Santosh *et al.* (2010) [4] and Tiwari and Kulmi (2004) [6] in Lepidium sativum.

Growth parameters viz., plant height (115.72 and 118.16 cm), number of branches $plant^{-1}$ (25.38 and 26.48), fresh weight (407.67 and 428.06 g) and dry weight $plant^{-1}$ (100.88 and 104.52 g) and days to flowering (85.66 and 90.12 days) was significantly increased with weeding and hoeing + organic residue mulch @ 4 t ha^{-1} as compared to organic residue mulch @ 4 t ha^{-1} and control during 2015-16 and 2016-17, respectively. Organic residue mulch @ 4 t ha^{-1} also produced significantly higher all growth parameters of chandrasur than control during both the years of study. Without moisture conservation practices (control) recorded minimum all growth parameters of chandrasur during both the years. These results are in close proximity with the findings of Awasthi *et al.* (2008) and Saikia *et al.* (2014) [7] in mustard.

3.2 Yield

The data on seed, stover and biological yield (q ha^{-1}), harvest index (%) and oil yield (kg ha^{-1}) of chandrasur as influenced by different irrigation scheduling, integrated nutrient management and moisture conservation practices during 2015-16 and 2016-17 have been presented in Table (2).

Seed yield (14.20 and 15.22 q ha^{-1}), stover (48.28 and 46.77 q ha^{-1}) and biological yield (62.48 and 61.98 q ha^{-1}), as well as harvest index (22.69 and 24.52%) and oil yield (377.97 and 408.26 kg ha^{-1}) of chandrasur was significantly increased with irrigation applied at 35 and 70 days after sowing as compared to irrigation given at 35 and 60 days after sowing and irrigation given at 35 days after sowing during 2015-16 and 2016-17, respectively. The increase in seed, stover, biological and oil yield of chandrasur with irrigation given at 35 and 70 days after sowing to the tune of 40.30, 31.84, 33.70 and 25.03 percent in 2015-16 and 34.93, 28.99, 30.37 and 22.03 percent in 2016-17 than irrigation given at 35 days after sowing, respectively. Irrigation given at 35 and 60 days after sowing also produced significantly more seed, stover and biological yield, harvest index and oil yield of chandrasur than irrigation given at 35 days after sowing during both the years of study. Similar findings have also been reported by Patnaik *et al.* (2016) [3] and Kumari and Patel (2015)

Application of 75% N through fertilizer + 25% N through vermicompost + PSB significantly increased seed (13.55 and 14.60 q ha^{-1}), stover (46.56 and 45.02 q ha^{-1}) and biological yield (60.12 and 59.62 q ha^{-1}), harvest index (22.50 and 24.44%) and oil yield (371.59 and 393.79 kg ha^{-1}) of chandrasur as compared to 75% N through fertilizer + 25% N through FYM and 100% N through fertilizer during 2015-16 and 2016-17, respectively. Seed, stover, biological and oil yield of chandrasur was increased to the extent of 26.52, 21.44, 22.57 and 20.21 percent in 2015-16 and 24.89, 20.37,

21.48 and 12.42 percent in 2016-17 with the application of 75% N through fertilizer + 25% N through vermicompost + PSB than100% N through fertilizer, respectively. The minimum yield and harvest index of chandrasur was recorded with the application of100% N through fertilizer during both the years of experimentation. The increase in yield and harvest index of chandrasur might be due to better growth and yield attributes with the use of organic and inorganic sources of plant nutrient. Similar results has also been reported by Santosh *et al.* (2010) [4].

Weeding and hoeing + organic residue mulch @ 4 t ha^{-1} produced significantly highest seed (13.47 and 14.56 q ha^{-1}), stover (46.74 and 45.38 q ha^{-1}) and biological yield (60.21 and 59.94 q ha^{-1}), harvest index (22.29 and 24.22%) and oil yield (369.81 and 401.24 kg ha^{-1}) of chandrasur than organic residue mulch @ 4 t ha^{-1} and control during 2015-16 and 2016-17, respectively. The increase in seed, stover, biological and oil yield of chandrasur with weeding and hoeing + organic residue mulch @ 4 t ha^{-1} to the tune of 23.69, 21.12, 21.69 and 18.32 percent in 2015-16 and 22.66, 21.01, 21.41 and 17.91 percent in 2016-17 than control, respectively. Significantly higher seed, stover and biological yield, harvest index and oil yield of chandrasur was recorded in organic residue mulch @ 4 t ha^{-1} and control during both the years of investigation. The increase in seed, stover and biological yield of chandrasur with different moisture conservation practices might be due to more availability of soil moisture through out the crop growth. The similar results has also been corroborated with the findings of Sharma and Jain (2011) [5]

Table 1: Growth attributes of garden cress as affected by different irrigation scheduling, integrated nutrient management and moisture conservation practices.

Treatments	Plant height (cm)		No. of branches plant^{-1}		Fresh weight plant^{-1} (g)		Dry weight plant^{-1} (g)		Days to flowering	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Irrigation Scheduling										
Irrigation at 35 DAS	102.78	105.12	22.49	23.94	329.44	351.23	90.59	95.33	78.18	82.22
Irrigation at 35 and 60 DAS	108.84	111.83	24.25	25.52	385.14	394.77	99.31	103.10	83.62	86.65
Irrigation at 35 and 70 DAS	113.56	116.77	25.51	26.55	398.74	416.16	103.01	106.43	85.25	87.57
SE (d)	1.26	1.43	0.33	0.09	2.89	6.30	0.95	0.87	0.37	0.25
CD (P=0.05)	3.50	3.97	0.93	0.26	8.01	17.48	2.63	2.42	1.03	0.68
Integrated Nutrient Management										
100% N (60 kg ha^{-1}) through fertilizer	104.53	106.92	22.94	24.23	347.47	371.21	95.19	99.38	80.38	82.07
75% N through fertilizer + 25% N through FYM	109.14	111.70	24.30	25.50	375.98	390.31	98.23	101.80	82.52	86.11
75% N through fertilizer + 25% N through vermicompost + PSB @ 2.5 kg ha^{-1} in soil	111.51	115.12	25.01	26.28	389.88	400.63	99.49	103.68	84.15	88.26
SE (d)	0.87	1.30	0.21	0.19	4.87	3.28	0.41	0.55	0.44	0.78
CD (P=0.05)	1.89	2.83	0.46	0.42	10.60	7.14	0.88	1.20	0.97	1.70
Moisture Conservation Practices										
Control	100.19	103.41	22.55	24.01	329.61	341.75	93.74	98.27	78.68	80.51
Organic residue mulch @ 4 t ha^{-1}	109.27	112.15	24.32	25.53	376.03	392.34	98.29	102.07	82.73	85.82
Weeding and hoeing + Organic residue mulch @ 4 t ha^{-1}	115.72	118.16	25.38	26.48	407.67	428.06	100.88	104.52	85.66	90.12
SE (d)	1.25	1.32	0.38	0.28	4.85	5.30	0.74	0.82	0.64	0.80
CD (P=0.05)	2.51	2.67	0.77	0.57	9.76	10.66	1.49	1.64	1.29	1.62

Table 2: Yield of garden cress as affected by different irrigation scheduling, integrated nutrient management and moisture conservation practices.

Treatments	Seed yield (q ha^{-1})		Stover yield (q ha^{-1})		Biological yield (q ha^{-1})		Oil yield (kg ha^{-1})		Harvest index (%)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Irrigation Scheduling										
Irrigation at 35 DAS	10.12	11.28	36.62	36.26	46.73	47.54	302.30	334.55	21.61	23.70
Irrigation at 35 and 60 DAS	11.99	12.85	42.12	40.45	54.10	53.30	349.41	378.67	22.12	24.08
Irrigation at 35 and 70 DAS	14.20	15.22	48.28	46.77	62.48	61.98	377.97	408.26	22.69	24.52
SE (d)	0.47	0.46	0.96	0.88	1.44	1.37	3.51	4.32	0.11	0.10
CD (P=0.05)	1.33	1.29	2.67	2.45	4.00	3.81	9.75	11.99	0.31	0.29
Integrated Nutrient Management										
100% N (60 kg ha^{-1}) through fertilizer	10.71	11.69	38.34	37.40	49.05	49.08	309.13	350.29	21.76	23.75
75% N through fertilizer + 25% N through FYM	12.04	13.06	42.11	41.05	54.16	54.12	348.97	377.40	22.17	24.09
75% N through fertilizer + 25% N through vermicompost + PSB @ 2.5 kg ha^{-1} in soil	13.55	14.60	46.56	45.02	60.12	59.62	371.59	393.79	22.50	24.44
SE (d)	0.55	0.55	1.01	0.94	1.53	1.43	3.08	3.63	0.14	0.14
CD (P=0.05)	1.20	1.21	2.21	2.06	3.34	3.32	6.73	7.90	0.32	0.30
Moisture Conservation Practices										
Control	10.89	11.87	38.59	37.50	49.48	49.37	312.54	340.13	21.93	23.98
Organic residue mulch @ 4 t ha^{-1}	11.94	12.93	41.68	40.58	53.63	53.51	347.34	380.11	22.20	24.09
Weeding and hoeing + Organic residue mulch @ 4 t ha^{-1}	13.47	14.56	46.74	45.38	60.21	59.94	369.81	401.24	22.29	24.22
SE (d)	0.41	0.46	1.05	0.99	1.54	1.46	3.09	3.41	0.08	0.04
CD (P=0.05)	0.83	0.92	2.14	2.01	3.14	2.98	6.20	6.85	0.18	0.08

4. Conclusion

From the present study, it may be concluded that integration of irrigation given at 35 and 70 days after sowing, application of 75% N through fertilizer + 25% N through vermicompost + PSB and weeding and hoeing + organic residue mulch @ 4 t ha^{-1} produced more growth parameters and yield of garden cress of Indo - gangetic plain zones of India.

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