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Research Article

Response of Chandrasur (*Lepidium Sativum* L.) to Sowing Durations and Stand Geometries

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Abstract

A field experiment was conducted during winter season of 2011-12 and 2012-13 at Udaipur, Rajasthan, to investigate the effect of different sowing durations and stand geometries on phenology, productivity and nutrient content and uptake of chandrasur (*Lepidium sativum* L.). Results revealed that sowing during 41 and 43 SMW being at par with each other took significantly less number of days to emergence compared to delayed sowing i.e. 45 and 47 SMW. However, crop sown during 43 SMW took significantly highest number of days to 50 per cent flowering (60.33) and days to 50 per cent pods formation (84.72). Moreover, the sowing of crop during 41 and 43 SMW remained at par but both these took significantly higher number of days for maturity (122.92) over 45 and 47 SMW. Likewise, significantly highest seed yield (2.25 t/ha), straw yield (8.79 t/ha), biological yield (11.04 t/ha) and total N (98.45 kg/ha) and P uptake (24.37 kg/ha) were recorded when crop was sown during 43 SMW. The highest net returns (INR 75.1 x 10^3/ha) and benefit-cost ratio (4.49) were also recorded with 43 SMW. Stand geometries did not influence significantly with respect to phenological characters of chandrasur crop. However, stand geometries at 30 cm x 10 cm resulted in significantly highest seed yield (2.07 t/ha) straw yield (8.34 t/ha). Likewise, significantly highest N content of seed (1.70%), and total N uptake (91.10 kg/ha) and P uptake (22.67 kg/ha), net returns (INR 68.0 x 10^3/ha) and benefit-cost ratio (4.06) were recorded when chandrasur sown at 30 cm x 10 cm stand geometry.

Keywords: Chandrasur, Nutrient content, Nutrient uptake, Standard meteorological week and Stand geometries

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Introduction

Chandrasur (*Lepidium sativum* L.) popularly known as Garden cress, is one of the medicinal plants belonging to Cruciferae family. It is antiscorbutic, depurative and stimulant. The seeds of Chandrasur are mainly used in preparation of medicines but roots and leaves also have the therapeutic values. Mucilage present in the seed coat is used to irritation of the mucous membrane of intestine in diarrhea and dysentery [1]. Chandrasur is also used against insect-bite and as an insect-repellent in the form of fumigant [2]. It is useful as traditional tonic to increase height of children and also increase the milk production in women and for curing chronic bronchial asthma [3]. About 960 species of medicinal plants are estimated to be in all India trade of which 178 species have annual consumption level in excess of 100 metric tonnes [4]. In India, Chandrasur cultivation is spread in patches across the states of Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat and Maharashtra in an area of about 8450 hectares. In Rajasthan, its cultivation is concentrated in tank beds without supplemental irrigation. The traditional method of sowing is to broadcast the seeds after the water has receded in post rainy season. It has low water requirement, not grazed by animals and is not attacked by insect pests. Its cultivation is highly remunerative. However, the quantum of research generated under AICRP on M&AP is very thin. There is an urgent need to develop agronomical practices such as sowing time, plant geometry etc. for obtaining good yield and to provide information to farmers for its production technology. Sowing time is the most important non-monetary practice affecting growth and yield of a crop. It is well known fact that the yields obtained from late sown crop is always lower than optimum sown. Late-sown crop also shorten the crop maturity. Both early and late sowing of this crop results in lower yields. It is, therefore, necessary to find out suitable time of planting which will ensure a balance between vegetative and reproductive phase of Chandrasur. The second important package is to provide non-competitive space between the plants as higher plant density adversely affects the growth and development and on the other hand, higher yield per plant obtained under wider. Spacing may not compensate the yield to be realized at optimum plant population. Another major constraint for garden cress is its cultivation on poor fertility soils. Nitrogen plays important role in the growth and development of the plant and its deficiency leads to sharp decline in the yield. An optimum supply of nitrogen is important for vigorous vegetative growth, chlorophyll formation and carbohydrate utilization. Thus, the present investigation was planned and carried out with the goal to find the suitable sowing durations and stand geometry, for cultivation of Chandrasur.

Materials and Methods

A field experiment was conducted during winter (*rabi*) seasons of 2011-12 and 2012-13 at Agronomy Research Farm, Rajasthan College of Agriculture, situated in the lap of Aravalli hills at 24^{o}35' N latitude and 74^{o} 42' E longitude with an altitude of 579.5 meters above mean sea level. The region falls under the agro- climatic zone IV-a (Sub-humid Southern plain and Aravalli hills of Rajasthan). Average annual rainfall of the region is around 600.8 mm. The soil of the experimental site was clay loam in texture and alkaline in reaction (pH 8.1). The soil was medium in available nitrogen (276.8 kg/ha) and phosphorus (19.00 kg P_2O_5/ha) and high in available potassium (365.5 kg K_2O/ha), respectively. The experiment was laid out in factorial randomized block design (RBD) with three replications, having 16 treatment combinations of four sowing durations, (41 standard meteorological week 08-14 October, 43 standard meteorological week 22-28 October, 45 standard meteorological week 05-11 November and 47 standard meteorological week 19-25 November) and four planting geometries (30 cm x 10 cm, 30 cm x 15 cm, 40 cm x 10 cm and 40 cm x 15 cm). The gross and net plot size were 3.6 x 4.2 m and 2.4 x 3.3 m during both the years of experimentations. Chandrasur variety 'MC-1' was sown using a seed rate of 8-10 kg/ha as per treatment during both the years. At the time of sowing, 1/3rd dose of nitrogen and full dose of phosphorus (30 kg P_2O_5) was applied as basal through urea and single super phosphate, respectively, by drilling these in crop rows about 4-5 cm below the seed. Remaining dose of nitrogen was applied at the time of first irrigation (25 DAS) and second irrigation (45 DAS) in equal quantity i.e. 1/3rd at each stage through urea as top dressing followed by irrigations. Sowing was done manually by dropping the seeds in lines in the furrows at a depth of about 1 cm as per the inter row spacing treatment. The seeds were covered with the thin layer of soil with the help of brushwood and irrigation was given immediately by check basin method after sowing through a slow stream. Afterward irrigations were applied to crop as per requirement i.e. 25 days after sowing; 45 days after sowing, 65 days after sowing and 85 days after sowing. To keep the crop free from weeds, two manual weeding and one hoeing were done, first at 30 days after sowing (DAS) and second at 60 DAS. In order to maintain desired plant population, thinning was done at 10 DAS by keeping plant to plant distance as per treatment during both years of experimentations. Harvesting of crop was done when plants turned golden yellow and maximum number of pods turned yellowish. The number of days taken for emergence was counted from the dates of sowing. Days to 50% flowering was recorded when 50% plants attained flowering, the number of days taken for 50% flowering were counted from the dates of sowing. Days to 50% pods formation was recorded when 50% plants attained pods formation; the numbers of days taken for 50% pods formation were counted from the dates of sowing. Days to maturity were counted when more than 90 per cent plants turned yellowish and attained maturity from sowing. 1000-seed were counted and weighed on an electrical top pan balance the weight was expressed as 1000-seed weight in grams. Seed yield (t/ha) seed obtained from individual net plots were weighed separately and seed yield was converted in q/ha to t/ha. Straw yield (t/ha) was computed by subtracting the corresponding seed yield from biological yield and expressed in terms of q/ha and finally converted into t/ha. Biological yield (q/ha) the weight of thoroughly sun dried harvested produce of each net plot was recorded separately before threshing as biological yield and it was converted in to t/ha. Plant samples (seed and straw) collected at harvest were sun dried and kept for oven drying for analysis. The nitrogen in samples was estimated by digesting plant samples with H_2SO_4 using hydrogen peroxide. Estimation of nitrogen was done by colorimetric method [5]. Phosphorous content was estimated using vanadomolybdo phosphoric acid to develop yellow colour after wet digestion of plant samples [6]. Nutrient uptake, the uptake of each nutrient (nitrogen and phosphorus) by seed as well as straw was computed by using the content and the final yield. Total uptake of each nutrient by crop was calculated by sum of the nutrient uptake of seed and straw in individual plot. Economic analysis was done on the basis of prevailing market prices of inputs and output obtained from each treatment. The statistical analysis of the data was done as per procedure of analysis of variance described by [7] were employed in order to test the significance of the experimental results.

Results and Discussion
Crop phonology

Sowing during 41 and 43 SMW being at par with each other took significantly less number of days to emergence compared to delayed sowing i.e. 45 and 47 SMW (**Table 1**). Further, sowing during 45 SMW also took significantly less number of days for emergence compared to 47 SMW during 2011-12 and in pooled data of two years. Crop sown during 43 SMW took significantly highest number of days to 50 per cent flowering and days to 50 % pods formation during both the years (Table 1). Successive delay in sowing from 43 to 47 SMW resulted in significant reduction in number of days taken by crop to 50 per cent flowering. Days to maturity of Chandrasur crop were significantly influenced due to sowing durations. Sowing during 41 and 43 SMW remained at par but both these took significantly higher number of days for maturity over 45 and 47 SMW during both the years of investigation. Sowing during 45 SMW also took significantly higher number of days compared to 47 SMW. Present investigation indicates that different stand geometries failed to affect to all phonological characters of Chandrasur crop significantly. Favorable effect of weather on crop growth recorded during present investigation on account of sowing during 43 SMW might be due to the fact that 43 SMW sown crop received favorable weather conditions in terms of relatively warm temperature during early growth and conducive temperature during flowering, pod formation and seed development stages. Whereas, late sown crop faced slightly low temperature at the early stage, which resulted in delay in germination and crop grew slowly during early growth period. Prevalence of low temperature at early stage and high temperature at terminal phase of the crop sown late might have adversely affected the growth of each developing structure. Similarly, early sowing (41 SMW) resulted in coinciding germination and early vegetative growth phase of crop with relatively high temperature; and grand growth phase, flowering and seed development stages with very low temperature, which ultimately restricts overall vegetative and reproductive development of plants.

Table 1 Phenology of Chandrasur as influenced by sowing durations and stand geometries (pooled basis)

Treatment	Days to emergence	Days to 50% flowering	Days to 50% pods formation	Days to maturity
Sowing durations				
41 SMW	3.55	56.03	82.25	117.81
43 SMW	3.67	60.33	84.72	122.92
45 SMW	4.08	53.84	74.98	108.58
47 SMW	4.37	44.12	70.20	100.96
SEm±	0.07	0.59	0.64	2.00
CD (P=0.05)	0.21	1.66	1.82	5.67
Stand geometries				
30 cm x 10 cm	3.75	53.90	78.50	117.88
30 cm x 15 cm	4.03	53.49	79.00	110.83
40 cm x 10 cm	3.84	53.68	76.50	112.36
40 cm x 15 cm	4.06	53.25	78.15	109.19
SEm±	0.07	0.59	0.64	2.00
CD (P=0.05)	NS	NS	NS	NS

It is generally believed that crop phenology is mainly influenced by genetic and environmental factors. In present study, it was reveal that crop sown during 41 and 43 SMW took significantly less number of days to emergence compared to delayed sowing i.e. 45 and 47 SMW (Table 1), probably on account of favorable temperature for germination prevailed during early sowing, while during late sowing significant decrease in temperature took place. Moreover, 43 SMW sown crop took significantly highest number of days to 50 % flowering, days to 50 % pods formation and days to maturity (Table 1), which shows that 43 SMW sown crop completed it's phasic development matched with the optimum requirement of temperature, which ultimately might have favored the crop growth. The significant reduction in duration (growth period) under late sown crop (45 and 47 SMW) and coinciding of reproductive phase with high temperature might have resulted in forced maturity of crop under delayed sowing. The profound effect of sowing time and resulting influence of temperature, humidity and sunshine hours on growth of *Brassica* crops have been reported by Bala *et al.* (2011) [8] and Mahmud Abadi *et al*. (2008) [9].Therefore, it necessitates here to briefly analyse the disposition of important weather parameters potent to yield variations in performance of Chandrasur under Udaipur conditions. Results of present investigation are in close conformity with those obtained by Yadav *et al.*, 2013 [10] and Chouhan and Padiwal, 2014 [11]. Results of present investigation further show that various crop phenological characters *viz.* days to emergence, 50% flowering, 50% pods formation and maturity were not influenced significantly due to various stand geometries (Table 1). In fact, during germination and emergence, there was no underground or aboveground competition for available resources, therefore, effect of various stand geometries were non-significant. Moreover, various phenological characters *viz.* days to 50%flowering, 50% pods formation and maturity are governed mainly by weather parameters and genetic make-up rather than stand geometry or arrangement of plants. Therefore, stand geometries not likely to change these traits. These findings corroborate the findings of Chark, 2005. [12]

Yield attributes and yield

The seed yield/plant (g), 1000-seed weight (g), seed (t/ha) straw yield (t/ha) and biological yield (t/ha) were significantly influenced due to sowing durations (**Table 2**). 43 SMW sown crop produced seed yield/plant significantly highest compared to all other sowing durations during both the years of investigation, which was followed both by 41 and 45 SMW sowings. Sowing during 47 SMW yielded seeds/plant significantly lowest during both the years. 43 SMW produced higher seed yield/plant compared to other standard meteorological week. Seed yield/plant was not influenced significantly due to various planting geometries. Sowing of Chandrasur during 43 SMW being at par with 41 SMW was found significantly superior over 45 and 47 SMW with respect to 1000-seed weight. Sowing during 41 SMW was found at par with 45 standard meteorological week but both these were superior to 47 SMW in this regard. 1000-seed weight was maximum under 30 cm x 10 cm, 30 cm x 15 and 40 cm x 10 cm as compared to 40 cm x 15 cm stand geometries geometry. It seems that sowing of crop during 43 SMW might have resulted in coinciding the favorable environmental factors, particularly temperature at various critical growth stages viz. grand growth, active branching, flowering, seed development, which ultimately might have synthesized and diverted the photosynthates for development of appropriate vegetative structure, which ultimately influenced yield attributes and yield favorably. Thus, as a consequence of favorable weather conditions, improvement in growth and yield components under 43 SMW sown crop might have resulted in realization of higher seed yield compared to other sowing durations.

Table 2 Yield attributes, yield and profitability of Chandrasur as influenced by sowing durations and stand geometries (pooled basis)

Treatment	Seed yield /plant (g)	1000-seed weight (g)	Seed yield (t/ha)	Straw yield (t/ha)	Biological yield (t/ha)	Net returns ($x10^3$ `/ha)	Benefit: cost ratio
Sowing durations							
41 SMW	10.49	2.03	1.77	7.57	9.35	56.0	3.34
43 SMW	12.93	2.08	2.25	8.79	11.04	75.1	4.49
45 SMW	11.42	1.97	1.91	7.65	9.57	61.5	3.67
47 SMW	9.95	1.69	1.60	6.43	8.05	48.9	2.92
SEm±	0.25	0.02	0.026	0.11	0.13	1.0	0.06
CD (P=0.05)	0.71	0.05	0.075	0.32	0.38	2.9	0.17
Stand geometries							
30 cm x 10 cm	11.47	1.98	2.07	8.34	10.42	68.0	4.06
30 cm x 15 cm	11.70	1.99	1.83	7.38	9.21	58.0	3.46
40 cm x 10 cm	10.81	1.96	1.93	7.80	9.74	62.3	3.72
40 cm x 15 cm	10.80	1.83	1.71	6.91	8.62	53.2	3.17
SEm±	0.25	0.02	0.026	0.11	0.13	1.0	0.06
CD (P=0.05)	NS	0.05	0.075	0.32	0.38	2.9	0.17

The significant increase in straw yield and biological yield under 43 SMW sowing seems to be on account of improvement in growth of crop in terms of dry matter accumulation along with the various morphological structures. Significant reduction in seed, straw and biological yields due to delayed sowing might be due to adverse effect of weather parameters, particularly temperature and humidity on growth and development of crop as discussed earlier. It seems that insufficient time was available for vegetative growth as the plant entered in the reproductive phase at a faster rate. The shorter growth period at early stage in late sown crop might have been resulted in poor plant canopy development. Generally, environmental variables may override genetic influences and as such, variations in weather parameters at different sowings exert their influence on the plant growth and ultimately yield. Mavi and Tupper

(2005) [13] also stated that plant can realize its genetic potential or complete its genetically programmed phasic development under certain range of environmental factors. The results corroborate with the findings of Chundawat, 2008 [14] and Choudhary *et al.*, 2010. [15]

Significantly highest seed, straw yield and biological yield (t/ha) was achieved under narrowest planting geometry of 30 cm x 10 cm and with each increase in available ground space/plant (i.e. decrease in plant population/hectare), there was significant reduction in seed straw and biological yield. As explained earlier, narrow spacing accommodated 333.0 x 10^3 plants/ha, which successively decreased under wider planting geometries i.e. 250.0 x 10^3 in 40 cm x 10 cm, 222.0 x 10^3 in 30 cm x 15 cm and 166.0 x 10^3 in 40 cm x 15 cm. Thus, it is clear that under narrowest planting geometry there were more number of main shoots and with each increase in spacing the reduction in main shoots took place, though these were substituted by emergence of more number of secondary and tertiary branches. It is well known fact that yield potential of main shoots generally remains higher than branches. Moreover, 1000-seed weight of the seeds produced by main shoots also remains higher than the seeds produced by branches. Thus, increased number of plants/main shoots/unit area under narrower planting geometries may be attributed to increase in seed and straw yield (t/ha) ha under present investigation. Net returns (INR 75197/ha) and benefit-cost ratio (4.49) of the crop sown during 43 standard meteorological week were significantly highest compared to all other sowing durations (Table 2). It might be due to direct influence of higher seed and straw yields obtained under this sowing duration. Thus, there was a greater increase in the monetary value of seeds and straw obtained under 43 standard meteorological week sowing, without any additional cost. The results are in agreement to those obtained by Choudhary *et al.*, 2010; [15] Maiti and Jat, 2013[16] and Yadav *et al.*, 2013.[10] Among the planting geometries net returns (INR 68008/ha) and benefit-cost ratio (4.06) of Chandrasur achieved due to narrowest stand geometry (30 cm x 10 cm) were significantly highest compared to wider planting geometries. This may be due to more seed and straw yield under this planting geometry compared to wider planting geometries with almost similar cost of cultivation for all stand geometries. The results are in close conformity to those reported by Chouhan and Padiwal, 2014 [11] and Maiti and Jat, 2013. [16]

Nutrient content and uptake

Results reveal that nitrogen and phosphorus uptake by seeds & straw; and total uptake of these nutrients were significantly highest under 43 SMW sown crop (**Table 3**). It was partly because of higher content of these nutrients in seed and straw and mainly on account of higher yields of seeds and straw under 43 SMW sown crop. It is well known fact that plants when receive favorable weather conditions at critical growth stages, their metabolic and photosynthetic activities also increases, which resulted in increased uptake of various plant nutrients. It is well established fact that nutrient uptake by the crop is largely dependent on it's growth and development. Primarily, it is a function of dry matter production and secondarily the concentration of nutrients at the cellular level. Under present study, nitrogen and phosphorus led to significant improvement in virtue of increase in morphological parameters and finally photosynthetic rate. The favorable temperature, light intensity and other weather parameters received at various critical growth stages due to sowing during 43 SMW might have increased synthesis of photosynthates, which was used by plants for increasing concentration of nitrogen and phosphorus in plants as it is well known fact that temperature and light intensity affect nitrate content of plants. Nitrate reductase activity increases under high light intensity [17] and nitrogen content critically relates to crude protein content and growth of plants. Adverse effect of delayed sowing on nitrogen concentration and growth of canola [18] and higher growth of *Brassica napus* under cooler and longer season environment than hot weather conditions [19] are some of weather dispositions that can also be related to chandrasur crop. The results are in close conformity with those obtained by Muhal *et al.* (2014) [20]. Nutrient content and uptake; and quality parameters of chandrasur seed show that these characters were influenced significantly due to effect of various stand geometries. Nitrogen content of seeds was significantly higher under stand geometries 30 cm x 10 cm, 40 cm x 10 cm and 30 cm x 15 cm compared to widest stand geometry 40 cm x 15 cm (Table 3).

However, nitrogen content of straw and phosphorus content of seed and straw were not influenced due to various stand geometries (Table 3). Further, uptake of nitrogen and phosphorus by seeds and straw; and total uptake of these nutrients by plants were significantly highest under narrowest stand geometry 30 cm x 10 cm and with successive increase in available space per plant by adopting wider stand geometry (decrease in plant population per hectare), there was significant reduction in uptake of these nutrients. It seems that under 30 cm x 10 cm, 40 cm x 10 cm and 30 cm x 15 cm stand geometries, the increased uptake of nitrogen from soil and efficient utilization of solar radiation might have improved the photosynthesis and carbohydrate metabolism in plants. The better translocation of photosynthetes to various plant parts might have increased the uptake of nutrients by the plants. Further, the nutrient uptake being the function of its content and seed and straw yield, the increased seed and straw yield of crop without dilution in nitrogen and phosphorus content might have led to increased uptake of these nutrients under narrow stand geometries. Similar results were also reported by charak *et al.*, 2006. [21]

Table 3 Nutrient content and uptake of chandrasur as influenced by sowing durations and stand geometries (pooled data of 2 years)

Treatment	N content (%)		Total N uptake (kg/ha)	P content (%)		Total P uptake (kg/ha)
	Seed	Straw		Seed	Straw	
Sowing durations						
41 SMW	1.698	0.680	81.07	0.4275	0.1623	19.89
43 SMW	1.743	0.687	98.45	0.4322	0.1664	24.37
45 SMW	1.687	0.675	84.16	0.4378	0.1624	20.82
47 SMW	1.650	0.652	69.63	0.4425	0.1605	17.45
SEm±	0.005	0.005	1.01	0.0023	0.0005	0.21
CD (P=0.05)	0.014	0.013	2.88	0.0065	0.0014	0.61
Stand geometries						
30 cm x 10 cm	1.708	0.670	91.10	0.4335	0.1636	22.67
30 cm x 15 cm	1.696	0.669	80.48	0.4329	0.1636	20.03
40 cm x 10 cm	1.701	0.676	85.66	0.4369	0.1622	21.14
40 cm x 15 cm	1.674	0.679	76.07	0.4367	0.1621	18.70
SEm±	0.005	0.005	1.01	0.0023	0.0005	0.21
CD (P=0.05)	0.014	NS	2.88	NS	NS	0.61

Conclusion

Based upon the results obtained two years experimentation, it is concluded that under the agroclimatic conditions of zone IVa (Sub-Humid Southern Plain and Aravali Hills) of Rajasthan, chandrasur (*Lepidium sativum* L.) crop should be sown during 43^{rd} Standard Meteorological Week (October 22-28) at 30 cm x 10 cm stand geometry (3.33 lakhs plants per hectare) to achieve higher productivity, profitability and quality.

Refrences

[1] Maiti, 2008. Research achievements. Annual Report (2007-08), National Research Center for Medicinal and Aromatic Plants, Boriavi, Anand: 25.

[2] Maurice, M. I. 1993. Handbook of African Medicinal Plants. CRC Press LLC, Florida.

[3] Paranjape, A. N. and Mehta, A. A. 2004. Lepidium sativum in chronic bronchial asthma. An experimental and clinical study. Indian Journal of Pharmacology 36(2): 117.

[4] Marichamy K, Yasoth Kumar N and Canesan A. 2014. Sustainable Development in Exports of Herbals and Ayurveda, Sidha, Unani and Homoeopathy (Ayush) in India. Science Park Research Journal 27(1): 01-06.

[5] Lindner R.C. 1944. Rapid analytical methods for some of the more common organic substances of plant and soil. Plant Physiolog y19: 76-84.

[6] Jackson, M. K. 1973. Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi.

[7] Gomez, K. A. and Gomez A. A. 1984. Statistical Procedures for Agricultural Research. A Willey Inter science Publication, John Willy & Sons, New York, pp. 317-356.

[8] Bala,P., A. K. Azad, and Hossain, M. F. 2011. Yield Response of Mustard to Sowing Date.Libyan Agriculture Research Center Journal International 2 (3): 112-117.

[9] Mahmud Abadi, A., Azizi M. and Gazanchian, A. 2008. The effect of planting date on the agriculture of different types of winter canola in the region of Bojnoored. In: Extended Summaries, Tenth Congress of Agriculture and Plant Breeding Science, 19-20 August 2008, Karaj, Iran. pp. 138.

[10] Yadav, L.R., Choudhary, S., Keshwa, G.L. and Sharma, O. P. 2013. Garden cress (Lepidium sativum) growth, productivity and nutrient uptake under different sowing dates, row spacing and nitrogen levels. Indian Journal of Agronomy 58(1): 114-118.

[11] Chouhan, G.S. and Padiwal, N.K. 2014. Effect of sowing durations and stand geometries on growth, productivityand quality of chandrasur (Lepidiumsativum). Annual progress report (2013-2014). All India

coordinated Research Project on Medicinal and Aromatic plants and Betelvine Directorate of Research, MPUAT, Udaipur-313001 (Rajasthan) pp.40-51.
[12] Charak, A. S. 2005. Effect of sowing time, row spacing and nitrogen levels on growth and yield of toria (Brassica campestris L.), Ph.D. Thesis, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur.
[13] Mavi, H. S. and Tupper, G. J. 2005. Agrometeorology: Principles and applications of climate studies in Agriculture, International Book Distributing Company, Lucknow, India.
[14] Chundawat R. S. 2008. Effect of sowing dates and seed rates on growth and yield of chandrasur. Biennial Report (2006-2007 & 2007-2008). All India Networking Research Project on Medicinal and Aromatic Plants. National Research Centre for Medicinal and Aromatic Plants, Boriavi, Anand, pp: 254
[15] Choudhary, S., Keshwa, G. L. and Yadav, L. R. 2010. Effect of sowing dates, row spacings and nitrogen levels on productivity, quality and economics of garden cress (Lepidiumsativum). Indian Journal of Agricultural Sciences 80(8): 752-4.
[16] Maiti, Satayabrata and Jat R.S. 2013. Effect of sowing dates and plant geometries on chandrasur. Annual Report (2012-2013) of All India Coordinated Research Project on Medicinal & Aromatic Plants and Betelvine, Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, pp: 171- 174.
[17] Umar, A. S. and Iqbal, M. 2007. Nitrate accumulation in plants, factors affecting the process and human health implications. Review Agronomy Sustainable Development 27 (1): 45-7.
[18] Hocking, P. J. 2001. Effect of sowing time on nitrate and total nitrogen concentration in field-grown canola (Brassica napus L.) and implications for plant analysis. Journal of Plant Nutrition 24 (1): 43-59.
[19] Rao, M.S.S and Mendham, N.J. 1991. Comparison of chinoli (Brassica compestris) and B. napus oil seed rape using different growth regulators, plant population densities and irrigation treatments. Journal of Agriculture Sciences 117: 177-8.
[20] Muhal, S., Solanki, N. S. Singh P. and Shukla K B. 2014. Effect of Salicylic acid on productivity and nutrient uptake of Brassica species under different planting durations. African Journal of Agricultural Research, 9(13): 1101-1106.
[21] Charak, A.S., Dadheech, R.C. and Shukla, K. B. 2006. Yield, quality and economics of toria as influenced by sowing time, row spacing and nitrogen levels. Journal of Research 5(2): 148-152.

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