LR-5086
[1-6]

RESEARCH ARTICLE Legume Research- An International Journal

Evaluation of Lentil Genotypes in Different Sowing Windows in the New Alluvial Zone of West Bengal

Anurag Bera[1,2], Rajib Nath[2], Purabi Banerjee[2,3], Ananya Ghosh[2,4], Md. Hasim Reja[2,5]

10.18805/LR-5086

ABSTRACT

Background: Being a cool season crop, lentil is very sensitive to temperature during its growth stages. It is found that delayed harvest of the preceding crop which is most frequently rice causes the majority of the country's lentil sowings to be postponed in India. As a result, the late-sown crop suffers during the seed-filling stage due to the rising high temperatures in most of its cultivated areas and results in lower yield. Therefore, there is a need to work out the optimum sowing time for realizing maximum yield potential as well as the selection of varieties suitable for normal as well as late sown condition of the crop.

Methods: A field experiment was carried out in the new alluvial zone of West Bengal at the District Seed Farm of BCKV, Kalyani during the two subsequent *rabi* seasons (November-March) of 2019-2020 and 2020-2021 to examine the difference in yield between normal and late seeding conditions for various lentil cultivars. There were a total of ten genotypes evaluated, with each one being planted at one of two different times (15th Nov and 30th Nov).

Result: The experimental findings revealed that lentil sown on 15th November recorded higher seed yield (2.34 t ha^{-1}) compared to 30th November sown crop (1.63 t ha^{-1}). Among the ten varieties, unreleased genotype C^{23}E^{21} recorded the highest seed yield (2.25 t ha^{-1}), followed by ILL 10802 (2.18 t ha^{-1}). According to the results of this study, delaying the sowing window from the middle to the end of November can reduce yields by as much as 27.77%. Therefore, it is prudent to encourage the lentil farmers in the new alluvial zone region of West Bengal to sow their crops no later than the 15th of November of the Rabi season, to prevent a drop in production.

Key words: Late seeding, Lentil, *Rabi* season, Seed yield, Sowing window.

INTRODUCTION

In India, poverty and malnutrition are regarded as the two most pressing issues in recent times. Grain legumes have been an essential component of a balanced diet with cereal since the dawn of civilization on several countries throughout the world. Lentil is one of the most important nutritious pulse crop, grown during *Rabi* season, or the Indian winter. In dry tract areas, lentil is often taken as only pulse crop that can be grown due to low soil fertility and limited moisture, making it an important source of protein for human consumption (Saoub *et al*., 2010). Lentil has an excellent nitrogen-fixing capacity and relatively low demand for external fertilizers, which make it an ideal crop for promoting environmental sustainability within the context of agricultural production systems ("Matny, 2015"; Erskine *et al*., 2011). The crop is generally planted as a rainfed crop in our country, following the *kharif* fallow or the following year's rice, maize, pearl millet harvest. Being a cool-season crop, the majority of India's lentil production is limited to the northern and central states. The five states of Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal and Jharkhand account for more than 90% of the nation's average annual production. According to DES, Ministry of Agriculture & FW, GOI, annual production of lentil records 1.61 million tonnes from the acerage of 1.55 million ha during 2017-18 final estimate. Although, our country contributes a larger proportion to the global annual production of the crop, but the productivity of the crop is still an issue on a global scale. Cultivated lentil covers roughly 1.5 million hectares of India's arable land, with an average productivity ranges between 847 to 1000 kilograms per hectare, which is significantly below than the global average of 1260 kilograms per hectare.

[1]Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India.
[2]Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Nadia, Mohanpur-741 252, West Bengal, India.
[3]Division of Crop Sciences, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad-500 059, Telangana, India.
[4]School of Agricultural Sciences, Sister Nivedita University, Kolkata-700 156, West Bengal, India.
[5]Department of Agriculture, Assistant Director of Agriculture, Basirhat-II block (743411), Government of West Bengal, Kolkata-700 124, West Bengal, India.

Corresponding Author: Anurag Bera, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, Uttar Pradesh, India.
Email: anuragbera123@gmail.com

How to cite this article: Bera, A., Nath, R., Banerjee, P., Ghosh, A. and Reja, M.H. (2023). Evaluation of Lentil Genotypes in Different Sowing Windows in the New Alluvial Zone of West Bengal. Legume Research. doi:10.18805/LR-5086.

Submitted: 09-12-2022 **Accepted:** 15-05-2023 **Online**: 06-06-2023

This variation in yield may be attributed to several obstacles, such as a lack of high-quality seeds, a lag in sowing, biotic and abiotic pressures and a knowledge gap in technology, which are faced by farmers during pulse production (Bera, 2021). In the eastern India particularly in West Bengal, lentil is not very much favoured as a *Rabi* crop due to it's low productivity and sensitivity to the barriers. Increasing the crop's production by fixing its bottlenecks is a top priority for the researchers to gain traction among growers. Sowing time is one of the most important non-monetary input having profound effect on lentil crop growth, phenological development, nodulation, pod development and productivity. The plant environment such as temperature, photo-period, moisture availability (in dryland condition) *etc*. is significantly differed with it's date of sowing. As a result, crop yield also gets varied. In this study, we evaluated how late sowing of lentils in West Bengal's new alluvial zone affected crop yields.

MATERIALS AND METHODS

The field experiment was carried out at District Seed Farm, Kalyani 'A-B' block, of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India during two subsequent *rabi* seasons (November-March) of 2019-2020 and 2020-21 (22°93′N latitude, 88°53′E longitude and 9.75 m above mean sea level). The experiment was set out using a split-plot design with three replications, where two distinct sowing dates (Nov 15 and Nov 30) were assigned to the main plots and ten different genotypes (BM-5, BM-7, Moitree, $C^{23}E^{21}$, ILL 10802, ILL 10893, IPL 220, IPL 534, L 4717, L 4727) in the sub-plots. Among all these ten genotypes, there were three pre-released genotypes, developed by ICARDA-BCKV collaborative projects, *i.e*. $C^{23}E^{21}$, ILL 10802, ILL 10893, which were tested with existing conventional varieties, *i.e*. BM-5, BM-7, Moitri, IPL 220, IPL 534, L 4717, L 4727. The experiment was carried out on a medium-sized plot of land that had well-drained Gangetic alluvial soil (order: Inceptisol), a clayey loam that possessed medium fertility and essentially neutral in reaction. The climate of this zone is of sub-tropical in nature which is characterised by hot and humid summers, erratic rainfall, high humidity and brief to moderate winters. The crop growing seasons of this area can be categorized into three *i.e*. dry and warm or pre-*kharif* (March-May), wet and warm or *kharif* (June-October) and dry and cool or *rabi* (November-February). The summer season is hot and dry, which receives rainfall with thunderstorm occasionally. The temperature begins to increase from the end of February, which reaches maximum during the month of April to May. Again, it starts to fall from mid-October reaching the minimum about 10°C by January. The foremost concern of our study, the *Rabi* or Winter season, is characterized by moderately low mean temperature, coupled with incidental showers and bright sunny days. During this course of study, an untimely light rainfall was observed during the middle of November and late January, which can be seen in the Fig 1. Seeds of ten lentil genotypes were sown at 25 cm row spacing in experimental plots (4 × 2.5 m) as per sowing time of various main plottreatments. Soaked seeds were soaked in *Rhizobium leguminosarum* culture and kept under shade for 1 hour before sowing in the field. The standard fertilizer dose of 20:40:40 kg ha^{-1} of $N:P_2O_5:K_2O$ was applied at basal in each experimental unit. Even though lentil can fix upto 85% of it's total nitrogen requirement through biological nitrogen fixation (BNF), still 20 kg N is applied at basal known as 'Starter Dose' (Saxena and Silim, 1990). The crop survived with good utilization of residual soil moisture left in the field and sometimes with little precipitation, hence no irrigation was given externally. Insect and weed infestations

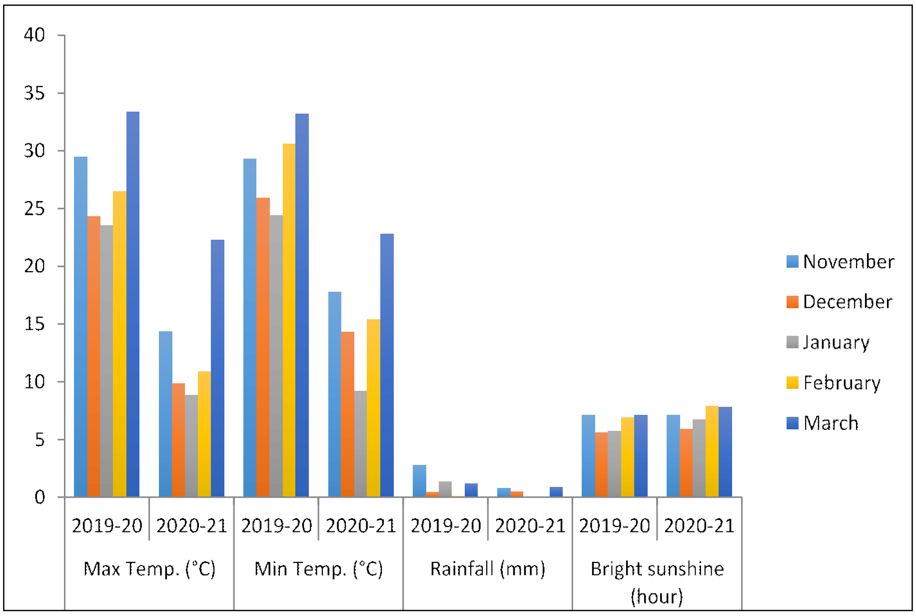


Fig 1: Graphical representation of meteorological data on monthly basis pertaining to the period of experimentation.

in the field were below the critical threshold, thus standard plant protection procedures were carried out, including one hand weeding at 30 days after sowing (DAS) and one fungicide spray of Hexaconazole 5% + Captan 70% WP @ 2.5 g lit^{-1} at 45 DAS.

Five randomly chosen plants were used as proxies for each plot and replication in order to record height and dry matter accumulation manually. Other plant phenotypic obsevations and growth characteristics determinant observations were recorded at 30, 60 and 90 days after sowing (DAS), as well as at harvest time. Yield components, seed yield, stover yield were counted individually during harvest following Sadasivam and Manickam (1996). The data collected for the various study parameters were statistically analysed using the analysis of variance (ANOVA) method for split-plot design. The 5% least significant difference was used to calculate the significance of the treatments (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The crop lentil showed an indeterminate type of growth habit comprising vegetative and reproductive stage intermingled together for a specific period. For both years 2019-20 and 2020-21, the tested genotypes exhibited consistent, rapid development from the time of emergence until 90 DAS. In this research, we have found that sowing time and variety had significant influence on crop phenology, growth attributes and yield parameters. Despite being 15 days behind schedule in terms of planting, the late-seeded crop matured ahead of schedule compared to the regularly sown types. Among all physiological parameters, plant height at initial period (30 DAS), nodule count at later stages (90 DAS) have shown highest correlation with seed yield, as shown in the Fig 2. However, among other growth parameters aerial dry weight has shown medium correlation with seed yield of the plant (Fig 2). In this context, we will discuss the outcome and the relevance of important growth parameters along with seed yield of lentil.

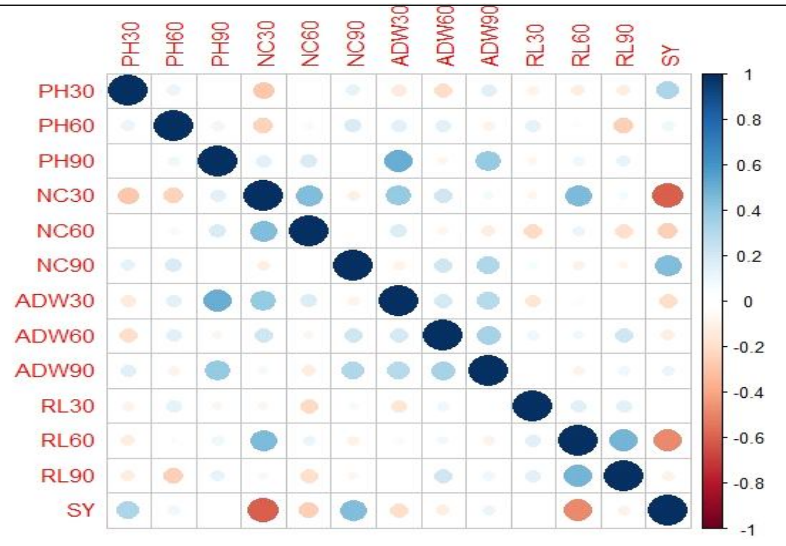
Growth parameters

• Plant height

Plant height is an important character which provides more or less idea about the plant growth. Lentil plant height was steadily increased from the seedling stage onward and then followed a platuing trend all the way up to harvest time. In case of growth attribute like plant height, we have observed that normal sown (15 Nov) plants recorded more plant height throughout the cropping period than the late sown (30 Nov) plants, except at 90 DAS (Table 1). The crop when sown on 15th November (D1), it recorded 18.99 cm. 26.77 cm. 45.28 cm at 30 DAS, 60 DAS and 90 DAS respectively. Whereas crop when sown on 30th November (D2), it recorded 17.51 cm. 26.69 cm. 46.42 cm. at 30 DAS, 60 DAS and 90 DAS respectively. In another field experiment, Mandi *et al*. (2015) found almost similar result which was conducted at Sriniketan during the 2014-2015 *rabi* season.

• Nodule count

The no of nodules per plant was significantly influenced by sowing time at 30, 60 and 90 DAS in the experiment. Sowing of lentil on 30th November resulted higher no of nodules in roots compared to early sown crop at 30 DAS and 60 DAS. But towards maturity when nodulation caesed, the rate of decline in the no of nodules was recorded higher in case of late sown crop (Fig 3). The changing rate of nodulation is likely due to the gradual increase in temperature experienced by the crop during its reproductive phases (Aranjuelo *et al*., 2015).



PH= Plant Height (30, 60, 90 DAS); RL= Root Length (30, 60, 90 DAS); NC= Nodule Count (30, 60, 90 DAS); SY= Seed Yield; ADW= Aerial Dry Weight (30, 60, 90 DAS).

Fig 2: Correlation plot among different physiological parameters and seed yield.

• Dry matter accumulation

When the rate of photosynthesis is higher than the rate of respiration, dry matter is accumulated and the plant grows. By observing plants at various stages, we can anticipate the plant growth phenomenon. In most cases, we consider aerial shoot dry weight for evaluating dry matter accumulation as it is clearly visible during field investigation. In this particular research on ten various lentil genotypes, we have found that lentil sown crop 30th November (D_2) accumulated more dry matter than 15th November (D_1) sown crops at each stage of plant growth (Table 2). Early sown crops recorded 19.47, 60.88, 123.81 g m^{-2} at 30 DAS, 60 DAS, 90 DAS respectively. Late sown crops recorded with 20.79, 61.76, 124.29 g m^{-2} at the following stages. These results for this trait in this experiment are consistent with those found in the report by Sen *et al*. (2016).

Seed yield

Owing to the similar pattern in plant growth attributes, nodulation characteristics, dry matter accumulation, yield attributes, it has been clearly observed that late sowing of

Table 1: Effect of sowing date and variety on plant height of lentil during 2019-20 and 2020-21.

Treatment	Plant height (cm) at different growth stages of lentil								
	30 DAS			60 DAS			90 DAS		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Sowing date (D)									
D_1:15 Nov	19.01	18.97	18.99	27.19	26.34	26.77	45.51	45.05	45.28
D_2:30 Nov	17.54	17.47	17.51	26.73	26.66	26.69	46.57	46.28	46.42
S.Em (±)	0.12	0.10	0.11	0.14	0.13	0.005	0.088	0.09	0.002
CD(P=0.05)	0.71	0.64	0.68	0.87	0.81	0.031	0.53	0.56	0.012
Variety (V)									
V_1	19.6	19.5	19.55	23.92	24.1	24.01	38.8	38.85	38.82
V_2	17.57	17.1	17.34	29.25	27.95	28.6	45.62	44.47	45.05
V_3	18.25	17.75	18	24.62	24.57	24.6	55.55	53.22	54.39
V_4	17.85	17.6	17.72	26.9	25.95	26.42	56.12	54.94	55.53
V_5	16.6	16.32	16.46	29.32	28.92	29.12	43.35	43.2	43.27
V_6	17.85	18.85	18.35	29.32	28.3	28.81	52.12	51.52	51.82
V_7	18.97	18.92	18.95	26.52	25.87	26.2	45.9	45.97	45.94
V_8	18.65	18.65	18.65	27.05	26.2	26.62	47.95	46.82	47.39
V_9	18.1	18.12	18.11	26.87	27.37	27.12	41.3	42.15	41.72
V_{10}	19.32	19.37	19.35	25.8	25.77	25.79	49.325	48.52	48.92
S.Em (±)	0.32	0.39	0.34	0.54	0.45	0.47	0.79	0.52	0.61
CD(P≤0.05)	0.92	1.11	0.97	1.55	1.29	1.36	2.27	1.49	1.75

Significant at P≤0.05; NS- Non significant at P>0.05.

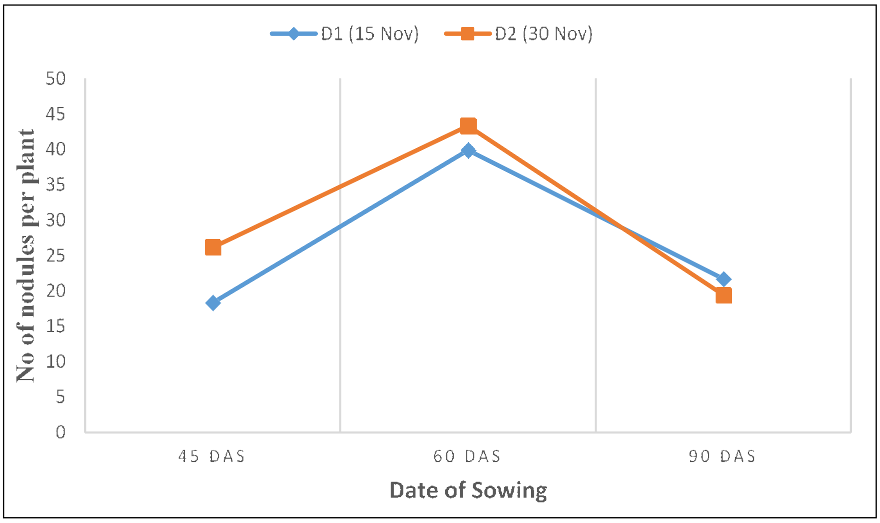


Fig 3: Graphical representation of sowing date influences the average number of nodules per plant at different growth stages.

lentil caused an irreparable yield loss for the crop. In this two year experiment, we have found a sharp decline in seed yield when the sowing time gets delayed by fifteen days from it's final date of normal recommendations. 15 November sown varieties have recorded 43.56% greater seed yield as compared to late sown crop. As can be shown in Table 2, late sowings can cause fluctuation in not only seed yield but also stover yield and harvest index of the crop. Roy *et al*. (2009) observed a similar outcome in a delayed sowing crop trial in the same agroclimatic zone in West Bengal. However, a long time ago Sekhon *et al*. (1986) suggested that, the ideal time for sowing of the lentil in Indian rainfed

Table 2: Effect of sowing date and varieties on dry matter accumulation of lentil

Treatment	Dry Matter accumulation (g) at different growth stages of lentil								
	30 DAS			60 DAS			90 DAS		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
					Sowing Date (D)				
D_1	19.28	19.67	19.47	60.64	61.12	60.88	124.99	122.63	123.81
D_2	20.44	21.15	20.79	61.99	61.52	61.76	124.59	123.98	124.29
S.Em (±)	0.003	0.10	0.05	0.17	0.14	0.15	0.27	0.32	0.3
CD(P=0.05)	0.016	0.64	0.33	1.01	0.82	0.92	1.66	1.93	1.8
					Variety (V)				
V_1	17.31	18.47	17.89	59.91	61.04	60.48	121.4	119.62	120.51
V_2	21.7	21.61	21.65	60.66	60.29	60.48	123.32	119.98	121.65
V_3	21.69	22.67	22.18	61.9	61.23	61.57	127.64	125.09	126.36
V_4	20.63	20.92	20.77	65.59	63.27	64.43	126.14	125.79	125.96
V_5	18.72	19.72	19.22	61.59	60.91	61.25	122.91	124.1	123.5
V_6	21.07	20.72	20.89	59.92	60	59.96	123.54	121.74	122.64
V_7	17.85	18.47	18.16	60.95	60.8	60.88	123.98	121.88	122.93
V_8	19.13	19.58	19.36	59.64	60.48	60.06	126.6	124.84	125.72
V_9	19.2	19.7	19.45	61.74	60.89	61.32	121.27	121.08	121.17
V_{10}	21.33	22.18	21.75	61.25	64.31	62.78	131.17	128.96	130.07
S.Em (±)	0.23	0.26	0.17	0.49	0.56	0.49	0.53	0.65	0.49
CD (P≤0.05)	0.65	0.74	0.49	1.42	1.6	1.41	1.52	1.85	1.41

Significant at P≤0.05; NS- Non significant at P>0.05.

Table 3: Effect of sowing date and variety on seed yield, stover yield, harvest index of lentil during 2019-20 and 2020-21*rabi* season.

Treatment	Seed yield (t ha^{-1})			Stover yield (t ha^{-1})			Harvest index		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
					Sowing date (D)				
D_1	2.32	2.36	2.34	3.84	3.85	3.84	0.37	0.38	0.37
D_2	1.61	1.65	1.63	2.94	2.9	2.92	0.36	0.36	0.36
S.Em (±)	0.006	0.01	0.01	0.006	0.02	0.03	0.004	0.003	0.003
CD(P=0.05)	0.038	0.06	0.05	0.038	0.12	0.16	0.023	0.019	0.02
					Variety (V)				
V_1	1.94	2.01	1.98	3.48	3.47	3.48	0.36	0.37	0.36
V_2	1.74	1.85	1.79	3.01	3.04	3.03	0.36	0.37	0.36
V_3	2.02	2.05	2.04	3.47	3.38	3.42	0.37	0.37	0.37
V_4	2.29	2.21	2.25	3.54	3.44	3.49	0.37	0.38	0.38
V_5	2.14	2.21	2.18	3.49	3.48	3.49	0.39	0.39	0.39
V_6	2.10	1.97	2.04	3.54	3.48	3.51	0.38	0.39	0.39
V_7	2.04	2.03	2.04	3.55	3.53	3.54	0.37	0.38	0.38
V_8	1.97	2.02	2	3.54	3.57	3.55	0.37	0.37	0.37
V_9	1.66	1.68	1.68	3.25	3.2	3.23	0.36	0.36	0.36
V_{10}	1.70	1.99	1.85	3.05	3.15	3.1	0.35	0.35	0.35
S.Em (±)	0.05	0.06	0.05	0.06	0.07	0.06	0.01	0.01	0.01
CD (P≤0.05)	0.14	0.19	0.14	0.17	0.19	0.18	0.02	0.02	0.02

Significant at P≤0.05; NS- Non significant at P>0.05.

condition ranges between third week of October to third week of November. Along with that, he also anticipated that, every 10 days before or after the ideal span time for sowing can result in a yield penalty (decrease) of 15.41-21.16% for the crop. The results of this experiment allow us to validate his older age forecasts in the real world. From Table 3, we can observe the variation in seed yield, stover yield and harvest index of lentil as influenced by sowing time in various genotypes.

CONCLUSION

Lentil is a sensitive crop based on its climatic requirement in different growth stages. Untimely rainfall, heat stress, pod abortion, pest incidence like undesirable encounter may reduce the crop yield. Keeping these points in consideration, sowing time has become one of the major non-monetary input for the cultivation of this crop. Based on the findings of this experiment, we could interpret that the best time to plant lentils is during a window of 15 days, which corresponds to the first two weeks of November. Hence, farmers of new alluvial zone of West Bengal are suggested to follow the recommendations for ensuring a better crop yield.

Conflict of interest: None.

REFERENCES

Aranjuelo, I., Aldasoro, J., Arrese-Igor, C., Erice, G., and Sanz-Sáez, Á. (2015). How does high temperature affect legume nodule symbiotic activity?. Legume Nitrogen Fixation in a Changing Environment: Achievements and Challenges. 67-87.

Bera, A. (2021). Impact of climate change on pulse production and it's mitigation strategies. Asian J Adv Agric Res. 14-28.

Erskine, W., Sarker, Ashutosh and Kumar, Shiv (2011). Crops that feed the world and Investing in lentil improvement toward a food secure world. Food Security J. 3(2): 127-139.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons.

Mandi, G., Sarkar, N.C., Palai, J.b., (2015). Effects of different sowing dates on growth of different lentil varieties. International Journal of Economic Plants. 2(3): 112-115.

Matny, O.N. (2015). Lentil (*Lens Culinaris Medikus*) current status and future prospect of production in Ethiopia. Adv Plants Agric Res. 2(2): 45-53.

Roy, A., Aich, S.S., Bhowmick, M.K., Biswas, P.K. (2009). Response of lentil varieties to sowing time in the plains of West Bengal. Journal of Crop and Weed. 5(2): 92-94.

Sadasivam, S. and Manickam, A. (1996). Biological Methods. 2nd Ed. New Age International Publishers, New Delhi, India.

Saoub, H.M., Haddad, N.I., Sadder, M.T. and Syouf, M. (2010). Morphological and molecular characterization of wild lentil collected from Jordan. J. on Crop Research (Hisar). 9(1/2/3): 50-61.

Saxena, M.C. and Silim, S.N. (1990). Food Legume Improvement Program: Annual Report. International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria.

Sekhon, H.S., Dhingra, K.K., Sadhu, P.S. and Bhandari, S.C. (1986). Effect of time of sowing, phosphorus and herbicides on the response to Rhizobium inoculation. Lens Newsletter 13: 11-15.

Sen, S., Ghosh, S., Mazumdar, D., Saha, B. and Dolui, S. (2016). Effect of sowing date and variety on phenology and yield of lentil during *rabi* season. Journal of Crop and Weed. 12: 135-138.