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Effect of micronutrients foliar spray on thermal Indices, phenology and yield of Lentil in new Alluvial Zone of West Bengal

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ABSTRACT

A field experiment was conducted at BCKV during *Rabi*, 2018-19 and 2019-20 to study the effect of Zn, Fe and B foliar spray on phenology and thermal indices of popular lentil variety, *Moitree* (WBL 77) under different sowing condition [1st week of November (normal) and 1st week of December (late)]. Delay in sowing of crop from November to December reduced the crop duration by 11.4 days (113.4 days vs 101.7 days). The variation in mean daily temperature and bright sunshine hour among two sowing dates resulted in varied accumulated Growing Degree Days (GDD), Helio Thermal Units (HTU) as well as Photo Thermal Unit (PTU). It was found that different dates of sowing have a larger impact on change in phenology of the crop and thus affect various thermal indices. Foliar spraying of micronutrients *viz.*, B + Fe @ 0.5% produced significantly higher seed and stover yield of 1438 kg ha^{-1} and 3981 kg ha^{-1}respectively, which were 86.26% and 27.0% more than that obtained from the control treatment (772 and 3134 kg ha^{-1}).The study conducted revealed that along with optimum date of sowing, spraying micronutrients especially a mixture of B+Fe@0.5 % and B+Zn+Fe@0.5 % couldalso bring in change of phenology to some extent. This may help in better accumulation of photosynthate hence, improving the yield responses of lentil.

KEYWORDS
Lentil, phenology, GDD, HTU, PTU

INTRODUCTION

Pulses occupy an important place in the food and nutritional security of the common man. Lentil (*Lens culinaris*) ranks second among *rabi* pulses in India, next to chickpea. Sowing time is an important management practices which can affect the growth to a larger extend (Singh *et al.*, 2015a). In India, most of the lentil sowings get postponed because of the delayed harvest of the preceding crop, which generally happens to be paddy, especially in northern and eastern part of India Singh *et al.*, 2015b. Changing weather has also impacted this crop. Prevailing weather conditions during the whole crop growing season have a direct association with the phenological developments in the crop plants, which modulate yield formation (Akhter and Islam, 2017).

Thermal unit indices vary with sowing time as well as different agronomic management practices. Often thermal unit indices like growing degree days (GDD), photo-thermal units (PTU), helio-thermal units (HTU) are used to correlate crop growth and development as these indices very well relate temperature and sunshine hours to crop growth and dry matter production (Prakash *et al.*,2018). These indices work to come up with recommendation for a specific area based on the local climate. GDD is found to be helpful to identify the duration of different biological processes and also adverse effect of temperature. Phenological development of a crop and its effect on growth and yield can be very well explained by these indices. Foliar application of micronutrients helps in the rapid translocation when compared to soil application which is very pertinent in mitigating stress in plants (Singh and Bhatt, 2015). Hence, we may expect that foliar spraying of Fe, Zn and B either individually or in combination may have some effect in changing the phenology of the crop and thus thermal requirement.

MATERIALS AND METHODS

The field experiment was conducted during *rabi season* (November – March) of 2018-19 and 2019-20 at the District Seed Farm, AB block, Kalyani, Bidhan Chandra Krishi Viswa vidyalaya, (Latitude 22º58' N and Longitude 88º32' E), West Bengal, India. The study site is flat and is located at an altitude of 9.75 m above mean sea level (AMSL). The climate of this zone is tropical sub-humid in nature with the characteristics of high summer temperature, high erratic rainfall, high humidity and short-mild winter. The crop seasons of the region are broadly classified as: dry and warm or *pre-kharif* (March-May); wet and warm or *kharif* (June-October); and dry and cool or *rabi* (November – February). The experiment was laid in a split-plot design with two sowing dates (November 1st week and December 1st week) in main plots and 9 foliar spray (S1: No spray, S2: Foliar spray of tap water, S3: Foliar spray of Zn @ 0.5 % ($ZnSO_4.7H_2O$), S4: Foliar Spray of Fe@ 0.5 % ($FeSO_4.7H_2O$), S5: Foliar spray of B @ 0.2 % (Borax 10.5 %), S6: Foliar spray of Zn@0.5% +B@0.2%, S7: Foliar spray of Zn@0.5% +Fe@0.5%, S8: Foliar spray of B@0.2% +Fe@0.5% and S9: Foliar spray of Zn@0.5% +Fe@0.5% +B@0.2%) in sub-plots replicated thrice. The seeds of popular variety *Moitree* (WBL 77) were sown at 30 cm row spacing in experimental plot of (5 m x 4 m) as per sowing time of main plot treatments. The standard crop management practices like uniform fertilizer dose of 20:40:40 kg ha^{-1} of N: P_2O_5 and K_2O, one hand weeding at 25-30 days after sowing (DAS) were given. No irrigation was provided because lentil was mainly grown on residual soil moisture along with

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little precipitation during *rabi* season and we had to see the crop stress during the growth.

The phenophases (*viz.* emergence, flower initiation, pod initiation and maturity) of lentil varieties sown at different dates were noted by regular field inspection method. The daily meteorological data at Kalyani for the period of investigation were collected from the AICRP on Agrometeorology unit, Directorate of Research, Kalyani, West Bengal. Phenophase-wise growing degree days (GDD) were calculated following Nuttonson (1955) by taking a base temperature of 5 ºC. Heliothermal units (HTU) and photothermal units (PTU) were determined by the equations proposed byPrakash *et al.*(2018). Ten random plants were selected from each plot, excluding border row, for taking observations on yield attributes of lentil. The analysis of variance (ANOVA) was done in split plot design. The significance of treatment differences was compared by critical difference (CD) at 5% level of significance (*P*=0.05) and statistical interpretation of treatments was done as per Gomez and Gomez (1984). The data over the years are pooled are presented in this paper.

RESULTS AND DISCUSSION

Phenology

The duration of lentil crop was significantly reduced with delay in sowing from normal to delayed (Table 1). On an average, lentil sown in November first week took 113.5 days from sowing to maturity compared to 102.1 days with sowing in December first. Singh *et al.* (2005) reported similar reduction in time to 50% flowering and maturity with delay in sowing of lentil (cv. LG 308) from 10 November to 10 December at Gurdaspur, Punjab. Sen *et al.* (2016) also reported similar trend in a study with four lentil varieties (HUL 57, Moitree, KLS 218 and Ranjan) sown on three different dates in West Bengal. Though the variations among the stages are not uniform, germination –flowering (G-F) and pod initiation to maturity (PI – M) noted in the study probably influenced the life cycle of lentil as a whole. The emergence of seedlings of lentil was relatively faster (7.1 days) in normal sown plots compared to late sown crop (8.1 days), which might be due to better residual soil moisture during post-rainy period after sowing. November son crop completed its life cycle in 113.5 days. However, December sown crop took only 102.1 days to complete the respective stages. Foliar spray of B+Fe @ 0.5% and B+Zn+Fe @ 0.5% resulted in an increase of three days when compared with no spray to attain maturity. This may be attributed to the fact that, as an indeterminate crop, foliar spray might have boosted the flower production resulting in a longer duration.

Table 1: Effect of date of sowing and foliar spray on phenology of lentil (pooled over two years)

Treatment	Sowing to emergence	Germination to flowering	Flowering to pod initiation	Pod initiation to maturity	Life cycle Sowing to maturity
Normal sowing	7.1	45.8	19.1	43.3	113.5
Delayed sowing	8.1	39.1	17.2	35.9	102.1
S.Em±	**0.04**	**0.12**	**0.07**	**0.07**	**0.03**
LSD	**0.17**	**0.47**	**0.28**	**0.29**	**0.10**
No spray	7.8	41.8	18.2	38.6	106.3
Tap water	7.6	42.3	17.7	39.1	106.8
Zn @ 0.5 %	7.4	42.1	18.1	39.4	107.2
Fe@ 0.5 %	7.6	42.4	17.7	39.6	107.3
B @ 0.2 %	7.7	42.5	17.8	40.0	108.0
Zn@0.5% +B@0.2%	7.7	42.7	18.3	39.6	108.2
Zn+Fe@0.5%, B@0.2% +Fe@0.5%	7.6 7.5	42.8 42.9	18.4 18.5	39.6 40.3	108.2 109.3
Zn@0.5% +Fe@0.5% +B@0.2%	7.8	42.8	18.5	40.6	109.4
S.Em±	**0.11**	**0.20**	**0.32**	**0.20**	**0.44**
LSD	**NS**	**NS**	**0.91**	**0.58**	**NS**

Growing degree days (GDD)

The temperature normally begins to rise from the end of February, reaches its maximum in May and starts to decline from mid-October, reaching the minimum of about 10ºC by January. The long-term average of annual rainfall of Gangetic West Bengal is about 1439 mm; of which 70 – 80% is received from the South-West monsoon which sets in during the second week of June. The relative humidity remains high during monsoon months *i.e.* from June to October. The cool and dry or *rabi* season, a prime concern of our study is characterized by moderately low mean air temperature along with bright sunny days.

Mean GDD from sowing to emergence (E), flower initiation (FI), pod initiation (PI) and maturity (M) for both the years are given in Figure 1. Mean air temperature was higher for December sown crop than November sown one, which accelerated the phenological development of the delayed sown crop especially during the flower initiation stage. The crop accumulated a total GDD of 1675 °C days and 1644.6°C days under normal sowing condition in two experimental years respectively. Whereas, delayed sowing accumulated a total GDD of 1514.9 °C days and 1488.8 °C days in two respective years. As, the crop is indeterminate type, the crop keeps on producing flower as far as the source sink relationship is maintained. We were able to see some significant difference in the GDD accumulated among the treatments. The treatment with foliar spray of B+Fe @ 0.5% has accumulated higher GDD in the first year (1621°C days) which was statically on par with foliar spray of B+Zn+Fe@0.5 % (1608.3°C days). In the second year, foliar spray of B+Zn+Fe@0.5 % accumulated higher GDD (1614.5 °C days) followed by B+Fe @ 0.5% (1608.6 °C). Though the differences are very less, it still could make some differences in longer run.

Heliothermal units (HTU)

The variation in mean daily temperature and bright sunshine hour among two sowing dates resulted in varied accumulated heliothermal units at different phenophases and life cycle of lentil crop. HTU also had a similar trend as GDD. The total HTU accumulated by the crop during the normal date of sowing was 11233.4 °C hour and 10925.2 °C hour in two consecutive growing seasons. The delayed sowing resulted in accumulation of 10083.2 and 10028.2°C hour in two years. The decrease in temperature during the germination phase of delayed sowing is the reason for less accumulation of HTU in sowing to germination stage (1315 vs 801.6 °C hour and 1108.5 vs 370 °C hour). Though not very significant still spraying of foliar spray has positive effects in accumulation and followed a similar trend as in case of GDD (Fig. 1).

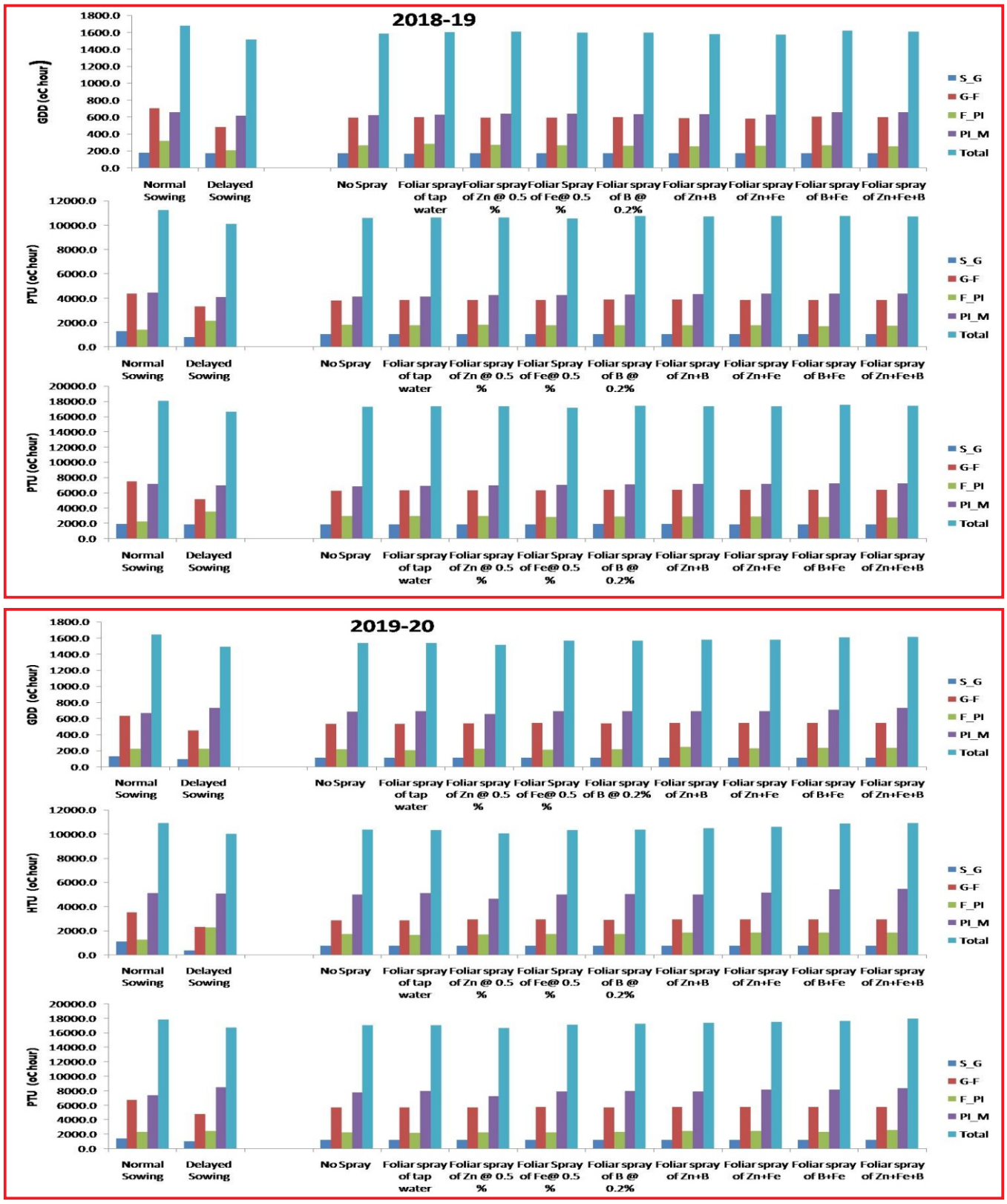

Fig 1: Effect of date of sowing and foliar spray on accumulated GDD, HTU and PTU (2018-19 and 2019-20)

Photothermal units (PTU)

Though temperature decides the onset of different phenophases in lentil crop day length also influence the photo-thermal requirements of the crop. The PTU accumulated by normal date of sowing was 18061°C hour and 17873. 7 °C hour whereas delayed sowing reported

an accumulation of 16609.5 °C hour and 16775.7 °C hour in both the years respectively. Foliar spray followed a similar trend as in case of GDD (Fig 1). A reduction in 11.67 days in the delayed sowing for the crop to complete its life cycle is the reason for reduction in accumulation of GDD, HTU and PTU. All these indices follow the trend reported by Sen *et al.*(2015).

Yield attributes and seed yield

Both sowing time and micronutrients foliar spray had significant influence on number of pods per plant, seed and stover yields of lentil (Table 2). November sown crop produced significantly higher number of pods plant^{-1} (127.2) compared to December sown crop (83.2). Lentil sown in November first week produced significantly highest seed yield (1328 kg ha^{-1}), which was 58.3 per cent higher over late sown crop (839 kg/ha). The results are in accordance with Sen *et al.*(2015), where the first fortnight of November was considered to be the optimum for sowing of lentil in New Alluvial Zone of West Bengal. Among the foliar spraying treatments, B +Fe @ 0.5% produced significantly higher seed yield (1438 kg ha^{-1}) followed by B +Zn + Fe @ 0.5% producing 1300 kg ha^{-1} (Table 2). Stover yield also followed the same trend as that of seed yield. Foliar spraying of B + Fe @ 0.5% produced significantly higher stover yield (3981 kg ha^{-1}) over other treatments. The results are in accordance with Visha *et al.* (2019) where they have found that foliar spray of boron and iron are highly beneficial in improving the yield of lentil in alluvial zones of West Bengal. The lowest yield was recorded in control (3134 kg ha^{-1}). This increase in grain and stover yields of lentil may be attributed to foliar spraying of micronutrients, which regulated their supply to the crop through mineralization with better absorption and may have prevented them from leaching and other losses. The availability of nutrients might have helped in increasing the translocation of photosynthates to sink leading to improvement in yield as reported by Singh and Bhatt (2015). The pooled results of harvest index did not differ significantly.

Table 2: Yield attributes of lentil as influenced by dates of sowing and foliar spraying of micronutrients (pooled data of 2 years)

Treatment	No. of pods	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Normal sowing	127.2	1328	3723
Delayed sowing	83.2	839	3346
S. Em±	**1.55**	**5.46**	**5.56**
CD(P=0.05)	**6.08**	**21.44**	**21.82**
No spray	81.4	772	3134
Tap water	89.1	829	3257
Zn @ 0.5 %	100.6	1020	3490
Fe@ 0.5 %	105.4	970	3357
B @ 0.2 %	107.5	1099	3535
Zn@0.5% +B@0.2%	113.2	1180	3583
Zn@0.5% +Fe@0.5%,	115.6	1144	3625
B@0.2% +Fe@0.5%	121.4	1438	3981
Zn@0.5% +Fe@0.5% +B@0.2%	112.6	1300	3847
S.Em±	**1.79**	**12.06**	**20.69**
CD(P=0.05)	**5.05**	**34.08**	**58.45**

CONCLUSION

Lentil being a cool season legume crop, delay in sowing can reduce the phenology of the crop due to increase in temperature during the later stages. Proper sowing time along with foliar spray of micronutrients especially Zn, Fe and B either individually or in combination could bring in changes in phenology of the crop and thus thermal requirement. This could help in better photosynthate assimilation and thus improve yield.

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