***TECHNOFAME- A** Journal of Multidisciplinary Advance Research*

Vol.8 No. 2, 36–45 (2019)

*Received: September, 2019; Accepted: October, 2019*

# Study of Crop Weather Relationship in Indian Mustard under Different Growing Environments

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## Abstract

*Field experiments were conducted at Agricultural Meteorology Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) during two consecutive rabi seasons study crop weather relationship in Indian mustard (Brassica juncea L. Czern. & Coss.) under different growing environments viz., sowing dates with growth manipulations. The correlation studies revealed that seed yield and its attributes were significantly and positively correlated with maximum and minimum temperatures, sunshine hours and evaporation during vegetative and flowering phases, but negatively during seed development phase. The regression analysis between seed yield and maximum temperature revealed that the coefficient of determination was higher during vegetative phase (0.71) but poor during the flowering phase and each 1°C rise of maximum resulted in 1.12 q ha$^{-1}$ increase in seed yield. Subsequently, during the seed development phase, each 1°C rise of maximum temperature resulted in 2.1q ha$^{-1}$ decrease in seed yield. The regression between seed yield and minimum temperature revealed that there was an average increase of seed yield by 1.34 q ha$^{-1}$ and 3.96 q ha$^{-1}$ with each 1°C rise in minimum temperature during the vegetative and flowering phase, respectively. However, at seed development phase a decrease in seed yield by 4.3 q ha$^{-1}$ was predicted with each 1°C rise in minimum temperature. The multiple regression analysis revealed that weather parameters had significant contribution in determining the seed yield.*

***Key words:*** *Growth manipulations, Indian mustard, sowing dates, weather, yield*

## Introduction

The agricultural production and productivity of any region is being regulated by the prevailing climate of that area through temperature, rainfall, light intensity, radiation, sunshine duration etc.[2]. The crop development and growth viz., phenology, biomass accumulation, leaf area index (LAI) and yield attributes are greatly influenced by the prevailing weather conditions. Mustard is very sensitive to weather and its response varies widely with change in growing environment. The present study was conducted to estimate the correlation between crop growth and yield with weather parameters, and to predict the effect of prevailing weather parameters on crop growth and grain yield through regression analysis.

## Materials and Methods

A field experiment was conducted on Indian mustard var. Laxmi during two consecutive *rabi* seasons of 2002-03 and 2003-04 at Agricultural Meteorology Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana). The experimental field was situated at 29°10’N Lat., 75°46’E Long. and 215.1 m amsl under irrigated conditions. The soil of experimental field was sandy loam in texture with 0.4% organic carbon, slightly alkaline in reaction (pH 7.9) and medium in fertility (available N 195 kg $ha^{-1}$, P 17 kg $ha^{-1}$and K 360 kg $ha^{-1}$). The experiment was conducted in split plot design with four replications, consisted three sowing dates *viz.*, 5 October ($S_1$), 20 October ($S_2$) and 5 November ($S_3$) as main plot treatments and 7 growth manipulations *viz.*, *c*ontrol or no manipulation ($L_1$), main shoot cut-off at 15 cm on 40 days after sowing ($L_2$), main shoot cut-off at 15 cm on 50 days after sowing ($L_3$), first primary branch cut-off on 55 days after sowing ($L_4$), second primary branch cut-off on 60 days after sowing ($L_5$), plant defoliated upto 50 cm above ground on 60 days after sowing ($L_6$) and plant defoliated upto 50 cm above ground on 75 days after sowing ($L_7$) as sub-plots treatments. The main shoot cut-off treatments ($L_2$ and $L_3$) were performed by cutting the 15 cm top part of main shoot at 40 and 50 days after sowing. Whereas, plant defoliation treatments ($L_6$ and $L_7$) were performed by removing lower leaves of plant upto 50 cm from ground level. The in-season growth manipulation treatments were executed manually as per the activity involved. Nitrogen @ 80 kg $ha^{-1}$ and phosphorus @ 40 kg $ha^{-1}$ was applied as per recommended agronomic practices. The seed was drilled in rows of 30 cm apart @ 5 kg $ha^{-1}$ and plants within a row were thinned to 15 cm. The crop was irrigated twice (at flowering and pod initiation stage) as per local recommendation by applying 6.0 cm water through flooding. The observations on leaf area index (LAI), number of siliquae $m^{-2}$, number of seeds $siliqua^{-1}$ and, 1000-seed weight (g) were recorded by selecting 5 plants from each plot. The seed yield (t $ha^{-1}$) and biological yield (t $ha^{-1}$) were recorded from net plot of 6.0m x 3.0m. The weather parameters such as maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours, and evaporation were averaged for different crop growth stages during both year of study. The correlation coefficients and linear and multiple regression equations were developed by using the computer software.

## Results and Discussion

### Crop-weather correlation studies

The correlation coefficients for leaf area index (LAI), seed yield and its attributes with weather parameters revealed that LAI, seed yield and its attributes were significantly and positively correlated with maximum and minimum temperature, sunshine hours and evaporation during vegetative and flowering phases, but negatively during seed development phase[1]. However, the correlations between seed yield and its attributes with relative humidity were negative during vegetative and flowering and positive during seed development phase (Table 1). The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with LAI at 40 days after sowing were 0.94, 0.92, 0.96 and 0.97, respectively during vegetative phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with LAI at 75 days after sowing were 0.61, 0.62, 0.58 and 0.60, respectively during flowering phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with seed yield were 0.84, 0.78, 0.91 and 0.86, respectively during vegetative phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with seed yield were 0.77, 0.87, 0.76 and 0.76, respectively during flowering phase of crop growth. Similarly, correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with number of silique $m^{-2}$ were 0.77, 0.74, 0.87and 0.82, respectively during vegetative phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with 1000-seed weight were 0.70, 0.70, 0.82 and 0.78, respectively during vegetative phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with 1000-seed weight were 0.64, 0.78, 0.70 and 0.68, respectively during flowering phase of crop growth. The correlation coefficients obtained for maximum temperature, minimum temperature, bright sunshine hours and evaporation with seeds $siliqua^{-1}$ were 0.70, 0.78, 0.76 and 0.74, respectively during flowering phase of crop growth.

**Crop-weather regression studies**

There was an average increase of 0.09 in LAI with each 1°C increase in maximum temperature during the vegetative and flowering phenophases with '$R^{2}$' values of 0.88 and 0.80, respectively. On the other hand there was an average decrease in LAI by 0.17 with each 1°C rise in maximum temperature with $R^2$ values of 0.92 during seed development phase (Fig. 1).The association of minimum temperature with LAI revealed that on an average there was an increase in LAI of the dimension of 0.12 and 0.35 with each 1°C rise in minimum temperature during vegetative and flowering phase with respective '$R^{2}$' value of 0.85 and 0.96. However during seed development phase 1°C rise in minimum temperature resulted in decrease of LAI value by 0.32[4]. The regression analysis for LAI vs. morning relative humidity revealed that each 1% rise in morning RH during vegetative and flowering phases led to decrease of LAI by 0.20 and 0.12 respectively and whereas during seed development phase an increase of LAI by a value of 0.21 occurred with 1% rise in humidity. While regression analysis with evening relative humidity showed that 1.0% rise in evening RH during vegetative and flowering phases caused decrease of LAI by 0.07 and 0.02. The regression equation between LAI and bright sunshine hours revealed that there was an average increase of LAI by 0.58 and 0.24 with every increase of one bright sunshine hour during vegetative and flowering phases[3]. However during seed development phase an average decrease in LAI by 0.43 occurred with increase in one bright sunshine hour. The linear regression equation developed for LAI and evaporation showed that with 1.0 mm $day^{-1}$ increase in evaporation rate during vegetative and flowering phases there was an average increase of LAI by 0.46 and 0.43, respectively. On the other hand during the seed development phase the LAI decreased by 0.58 with 1.0 mm $day^{-1}$ increase in evaporation rate. The regression analysis between seed yield and maximum temperature revealed that the coefficient of determination was higher during vegetative phase (0.71) but poor during the flowering phase and each 1°C

**Table 1 Correlation coefficient (r) for seed yield, its attributes and LAI with weather parameters during various phenophases in mustard**

| Weather parameters | Phenophase | Seed yield q $ha^{-1}$ | Biological yield q $ha^{-1}$ | No. of siliquae $m^{-2}$ | Seeds $siliqua^{-1}$ | 1000-seed weight (g) | LAI 40 DAS | LAI 50 DAS | LAI 60 DAS | LAI 75 DAS | LAI 100 DAS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_{max}$ | Vegetative | 0.84** | 0.85** | 0.77** | 0.73** | 0.70** | 0.94** | 0.42 | 0.46* | 0.63** | 0.57** |
| | Flowering | 0.77** | 0.77** | 0.70** | 0.70** | 0.64** | 0.89** | 0.35 | 0.49* | 0.61** | 0.49* |
| | Seed development | -0.85 | -0.85 | -0.78 | -0.77 | -0.75 | -0.96 | -0.35 | -0.49 | -0.66 | -0.59 |
| $T_{min}$ | Vegetative | 0.78** | 0.80** | 0.74** | 0.76** | 0.70** | 0.92** | 0.47* | 0.52* | 0.62** | 0.55** |
| | Flowering | 0.87** | 0.88** | 0.81** | 0.78** | 0.78** | 0.98** | 0.44* | 0.45* | 0.62** | 0.60** |
| | Seed development | -0.94 | -0.93 | -0.90 | -0.85 | -0.88 | -0.97 | -0.48 | -0.50 | -0.69 | -0.76 |
| $RH_{max}$ | Vegetative | -0.87 | -0.87 | -0.83 | -0.79 | -0.77 | -0.97 | -0.50 | -0.53 | -0.67 | -0.62 |
| | Flowering | -0.85 | -0.83 | -0.81 | -0.81 | -0.77 | -0.95 | -0.55 | -0.57 | -0.65 | -0.62 |
| | Seed development | 0.96** | 0.93** | 0.92** | 0.88** | 0.88** | 0.97** | 0.50* | 0.57** | 0.73** | 0.77** |
| $RH_{min}$ | Vegetative | -0.85 | -0.82 | -0.82 | -0.66 | -0.77 | -0.80 | -0.49 | -0.39 | -0.58 | -0.68 |
| | Flowering | -0.80 | -0.79 | -0.76 | -0.78 | -0.72 | -0.92 | -0.53 | -0.53 | -0.60 | -0.56 |
| | Seed development | 0.95** | 0.94** | 0.91** | 0.87** | 0.88** | 0.98** | 0.48* | 0.54* | 0.71** | 0.76** |
| BSSH | Vegetative | 0.91** | 0.90** | 0.87** | 0.79** | 0.82** | 0.96** | 0.53* | 0.53* | 0.69** | 0.68** |
| | Flowering | 0.76** | 0.76** | 0.73** | 0.76** | 0.70** | 0.89** | 0.53* | 0.53* | 0.58** | 0.53* |
| | Seed development | -0.95 | -0.93 | -0.90 | -0.87 | -0.87 | -0.99 | -0.48 | -0.57 | -0.73 | -0.74 |
| Ep | Vegetative | 0.86** | 0.86** | 0.82** | 0.80** | 0.78** | 0.97** | 0.51* | 0.54* | 0.66** | 0.62** |
| | Flowering | 0.76** | 0.76** | 0.72** | 0.74** | 0.68** | 0.90** | 0.48* | 0.53* | 0.60** | 0.52* |
| | Seed development | -0.96 | -0.93 | -0.91 | -0.87 | -0.88 | -0.98 | -0.50 | -0.56 | -0.72 | -0.76 |

** Significant at (P = 0.01) level of significance

* Significant at (P = 0.05) level of significance

**Table 2 Multiple Regressions between seed yield and weather parameters in mustard**

| **Growth phases** | **Multiple regression equation** | **$R^2$** |
|---|---|---|
| **Vegetative phase** | | |
| S1 | $Y= 3004.7-16.9 X_1 - 32.0 X_2 - 21.6 X_3 - 175.7 X_4 + 185.0 X_5$ | 0.60** |
| S2 | $Y= 4467.6 + 0.78 X_1 - 36.4 X_2 - 40.5 X_3 - 248.5 X_4 + 94.2 X_5$ | 0.98** |
| S3 | $Y= -969.7+2.5 X_1-27.4 X_2 + 12.9 X_3 - 107.5 X_4+ 412.0 X_5$ | 0.27* |
| **Flowering phase** | | |
| S1 | $Y= 405.9 + 7.4 X_1 + 3.6 X_2 - 5.5 X_3 - 9.3 X_4 - 67.0 X_5$ | 0.96** |
| S2 | $Y= 804.6 + 0.1 X_1 + 0.1 X_2 – 7.5 X_3 – 12.1 X_4 - 97.2 X_5$ | 0.70** |
| S3 | $Y= -68.8 + 3.1 X_1 - 5.3 X_2 + 0.6 X_3 + 6.7 X_4 - 27.1 X_5$ | 0.98** |
| **Seed development phase** | | |
| S1 | $Y= 794.5 + 17.4 X_1 - 25.2 X_2 + 0.17 X_3 - 328.0 X_4+ 545.0 X_5$ | 0.99** |
| S2 | $Y= 919.8 + 2.1 X_1 – 43.3 X_2 -10.9 X_3 + 17.1 X_4 + 23.0 X_5$ | 0.89** |
| S3 | $Y= -409.4 - 11.6 X_1 + 144.5 X_2 - 0.7 X_3 + 69.5 X_4-321.2 X_5$ | 0.98** |

$X_1$= Tmax, $X_2$= Tmin, $X_3$= Rh mean, $X_4$= BSSH, $X_5$= Ep
** Significant at (P = 0.01) level of significance
* Significant at (P = 0.05) level of significance

rise of maximum temperature resulted in 1.12 q $ha^{-1}$ increase in seed yield (Fig. 2). However, during the seed development phase each 1°C rise of maximum resulted in 2.1q $ha^{-1}$ decrease in seed yield. The regression between seed yield and minimum temperature revealed that there was an average increase of seed yield by 1.34 q $ha^{-1}$ and 3.96 q $ha^{-1}$ with each 1°C rise in minimum temperature during the vegetative and flowering phase, respectively. However, at seed development phase a decrease in seed yield by 4.3 q $ha^{-1}$ occurred with each 1°C rise in minimum temperature. During vegetative and flowering phases, when the crop generally encounters lower day and night temperatures, an increase in temperature is likely to promote plant growth and development. Whereas during seed development and maturity phases, when the temperature generally is on rise this will lead to forced maturity resulting in poorer yield attributes and final seed yield. The regression analysis between bright sunshine hours and seed yield indicated that during vegetative phase there was an average increase of 37.5 q $ha^{-1}$ yield by 1.0 hour increase of bright sunshine duration. However, during the seed development phase, a decrease of 5.6 q $ha^{-1}$ occurred with increase of 1.0 bright sunshine hour. The regression analysis between seed yield and pan evaporation

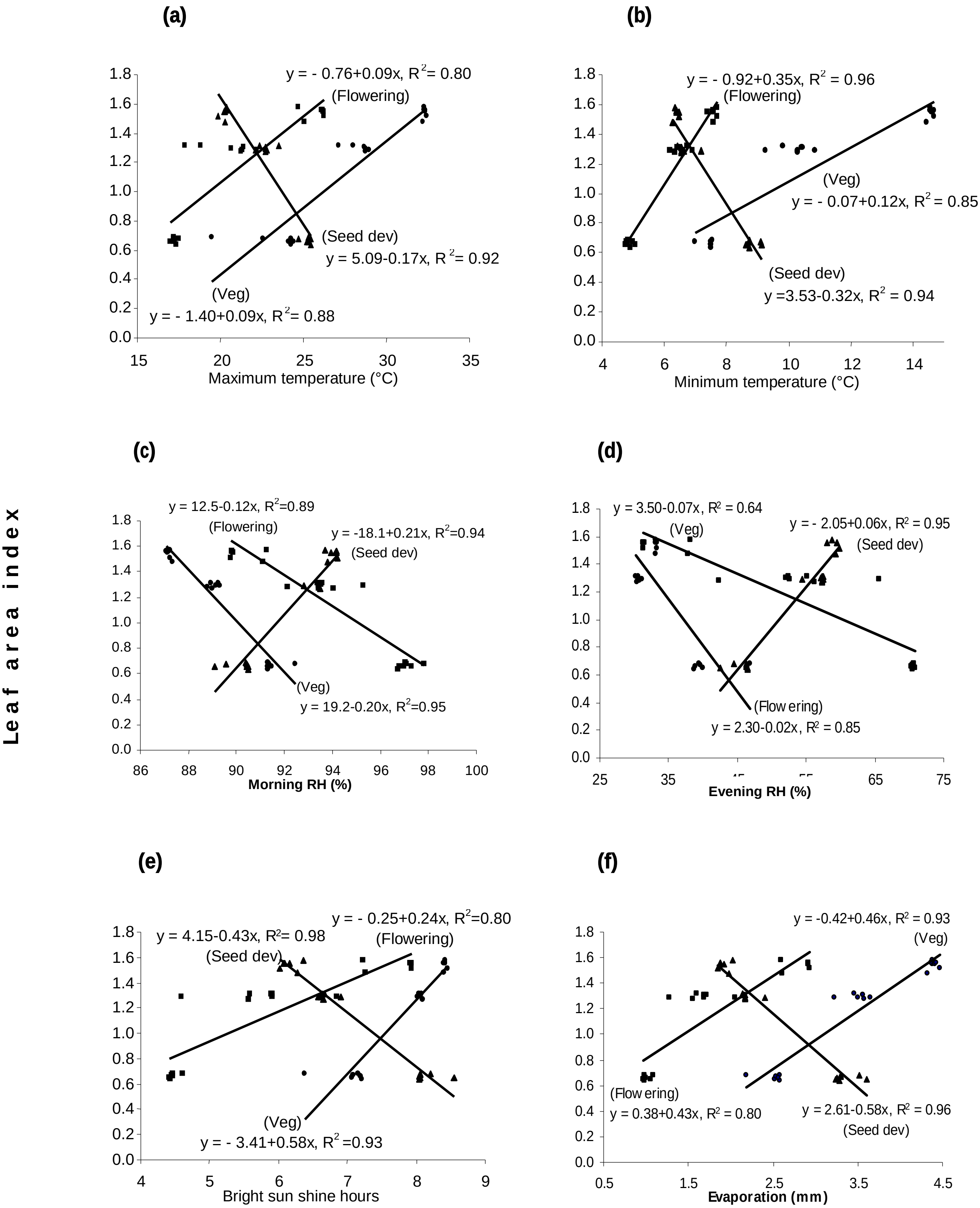


Fig. 1: Relationship between LAI and (a) maximum temperature; (b) minimum temperature; (c) maximum RH; (d) minimum RH; (e) bright sunshine hours; (f) evaporation at different

phenophases

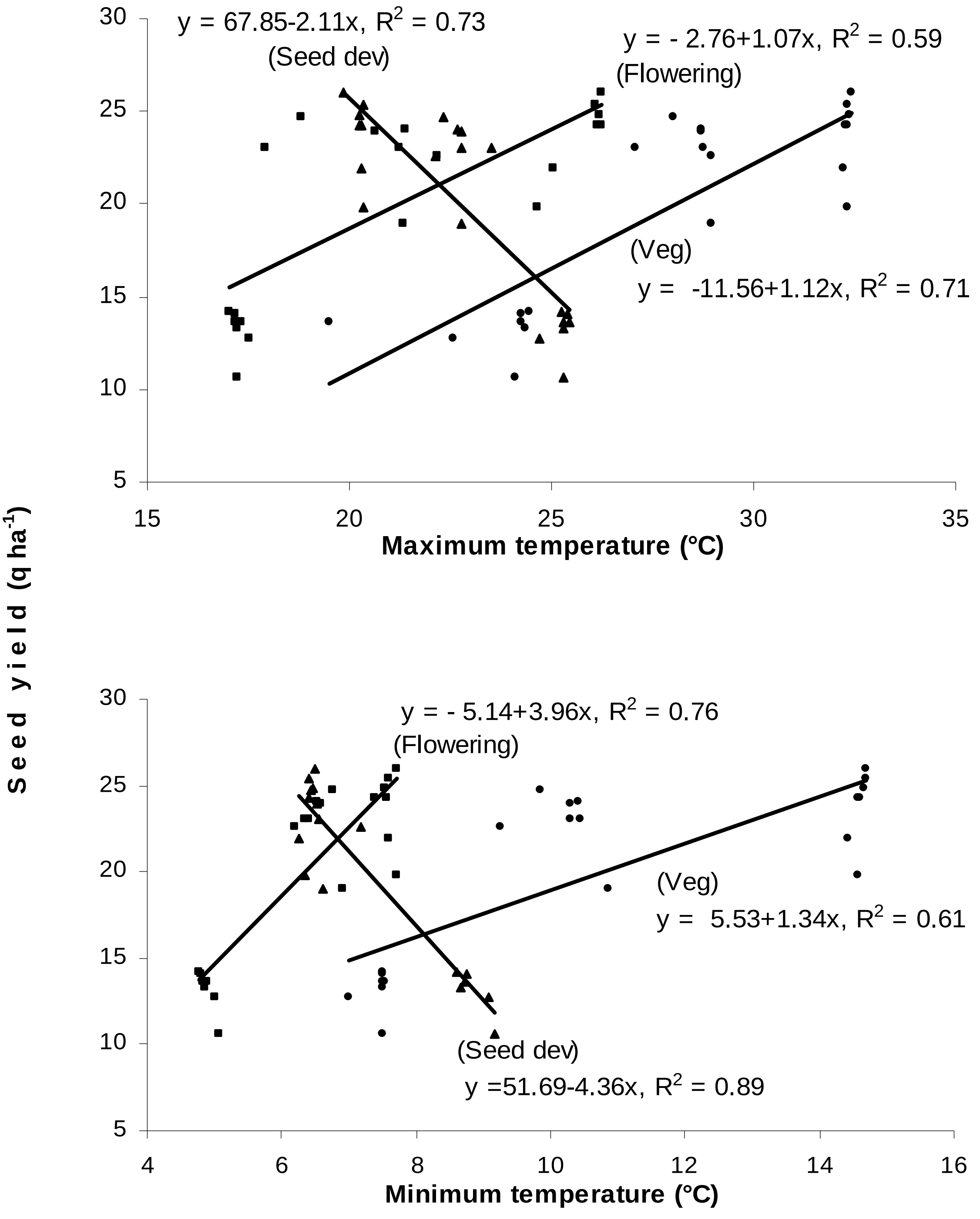


Fig. 2: Relationship between seed yield and (a) maximum temperature; (b) minimum temperature at different phenophases

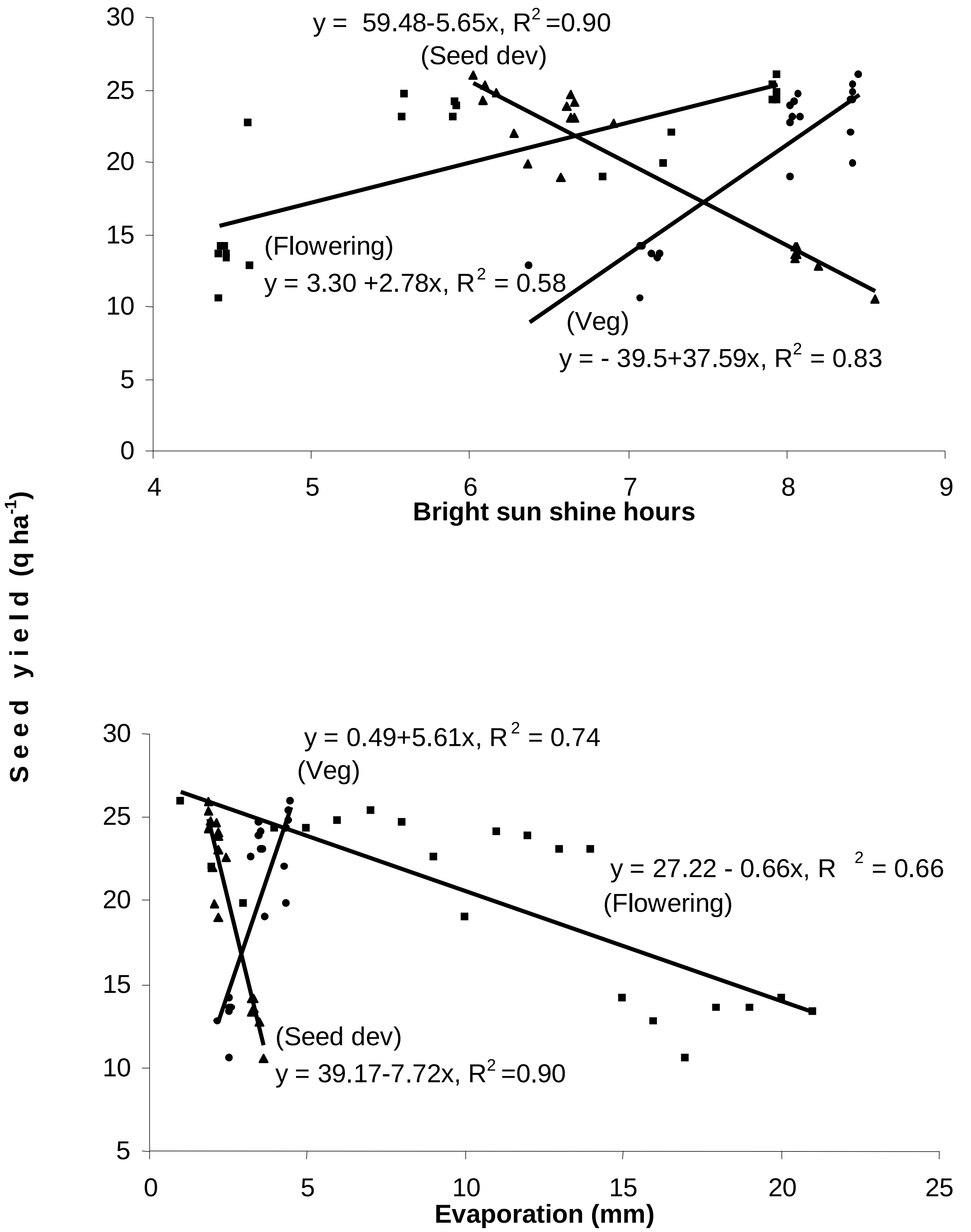


Fig. 3: Relationship between seed yield and (a) bright sunshine hours; (b) evaporation at different phenophases

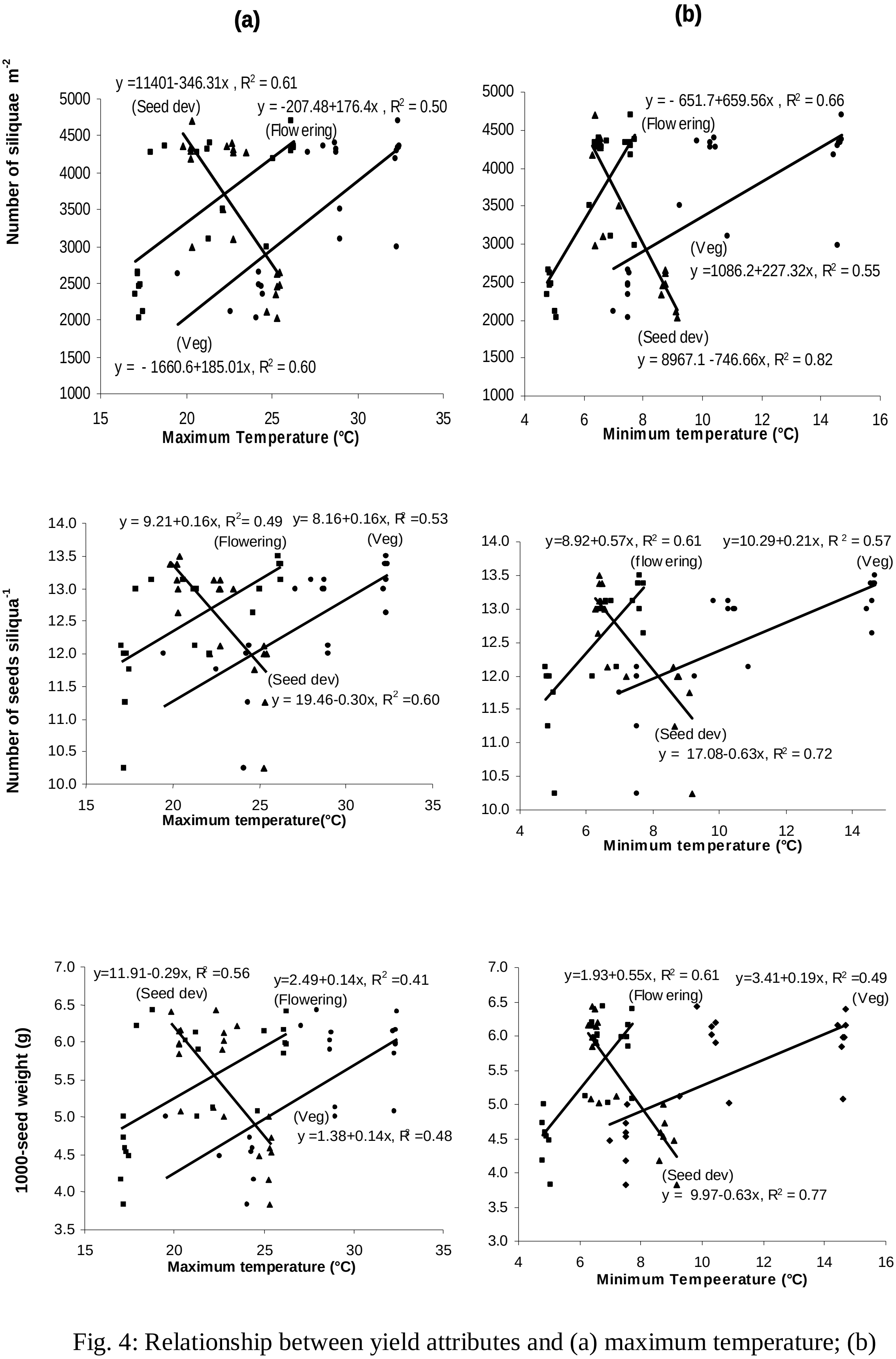


Fig. 4: Relationship between yield attributes and (a) maximum temperature; (b) minimum temperature at different phenophases

rate per day revealed that there was an average increase of 5.6 q $ha^{-1}$ with 1.0 mm $day^{-1}$ rise in evaporation during vegetative phase ($R^2$ =0.74). Whereas, during seed development phase the rise in evaporation rate by 1.0 mm $day^{-1}$ resulted in decrease in seed yield by 7.72 q $ha^{-1}$. The multiple regression equations were developed using the five weather parameters *viz*., maximum temperature, minimum temperature, relative humidity, bright sunshine hours and evaporation which showed their application in determining the seed yield during simple correlation studies during vegetative, flowering and seed filling phases of crop growth (Table 2). It was found that these weather parameters had significant contribution in determining the seed yield in different sowings dates during the three important phenophases since the coefficient of determination ($R^2$) were highly significant.

**Conclusion**

On the basis of results obtained from two years field study conducted to explore different sowing dates and mid-season crop growth manipulations in Indian mustard var. Laxmi under semi-arid conditions of Hisar, it can be concluded that LAI was significantly and positively correlated with mean maximum and minimum temperature, bright sunshine hours during vegetative and flowering phenophases but, negatively correlated with these weather parameters during seed development phase. The seed yield and yield attributes were also significantly and positively correlated with maximum and minimum temperature, sunshine hours and evaporation during vegetative and flowering phenophases but, negatively correlated at seed development phase. Multiple regression analysis indicated that the different weather parameters. *viz.,* maximum temperature, minimum temperature, relative humidity, bright sunshine hours and evaporation contributed very significantly in the determination of seed yield under different sowings dates during vegetative, flowering and seed filling.

**References**


1. Chaudhari, K.N., Oza, M.P., Ray, S.S. (2009). Impact of climate change on yields of major food crops in India. ISPRS Archives 38-8/W3 Workshop Proc Impact of Climate Change on Agriculture. ISPRS Ahmadabad, Space Applications Center (ISRO) Ahmadabad, India, 17—18 Dec , pp. 100—105.
2. Goswami B., Mahi, G. S. and Saikia, U. S. (2006). Effect of few important climatic factors on phenology, growth and yield of rice and wheat. Agricultural Review 27: 223-228.
3. K. Ankit, Singh, M. Yadav, R.K., Singh, P. and Lallu. (2018). Study of correlation and path coefficient among the characters of Indian mustard. The Pharma Inno. Journal, 7(1): 412-416.
4. K., Yogesh, Singh R., Singh D., K., Anil, Dhaka, A.K. (2017). Influence of weather parameters on yield and yield attributes of mustard (Brassica juncea) at Hissar Condition. Environment & Ecology, 35 (2C) : 1274–1280.