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Study the relationship of barley with growth-yield, weather and agrometeorological condition under different growing environments

Renu, Anil Kumar, CS Dagar and Raj Singh

Abstract
The field study was conducted in *rabi* 2019-20, experiment was comprised of four growing environment under Hisar condition i.e. as factor (A) namely (D1) -15th November, (D2) – 30th November, (D3) – 15th December and (D4) – 30th December, comprising four different cultivars factor (B) *viz*. (V1)- BH 393, (V2)-BH 902, (V3)- BH 946 and (V4)-BH 885. As prevailed weather condition which has been influenced the positive and negative relationship during crop growth, development and productivity under the semi-arid region. The mainly diurnal variable weather parameters are much influenced the crop growth, nutrient uptake and assimilation in the barley crop. The experiment was laid out in factorial RBD design with three replications. The crop sown on the first fortnight of November (D1) demonstrated high growth in terms of yield and yield-contributing characteristics, and the variety BH 393(V1) produced superior grain and biological yield in comparison to other varieties. Using correlation analysis, the correlations between growth, weather and agrometeorological indices, and yield and yield attributes were investigated at various crop growth stages. Plant growth parameters; the association between plant height or LAI and GDD, HTU, or PTU is significantly stronger than that between TUE and RUE. Total dry matter exhibits a stronger correlation with all agrometeorological indices after the Booting stage; significant negative association with GDD, HTU, and PTU, or significant positive association with RUE and TUE. Correlation between agrometeorological indices or weather parameters reveals that GDD, HTU, or PTU were significant positive association with Tmax or Tmin, and RUE or TUE were significant negative association with Tmax or Tmin. Among yield and yield attributes awn length and straw yield shows the significant association with weather parameters.

Keywords: Barley-weather relation, growing environments heat-energy efficiency, agrometeorological indices

1. Introduction

After rice, wheat, and corn, barley (*Hordeum vulgare* L.) is one of the most important cereal grain crops. Barley was primarily used as livestock feed in the past, but it is now one of the grains consumed by humans (barley malt). Additionally, barley plays a vital role in industrial consumption (Vaezi *et al*. 2010) [11]. It has a brief growing season. In India, barley is typically grown as a *rabi* season crop, with sowing occurring between November and December and harvest beginning between April and May. Haryana ranks sixth in the nation for barley production and contributes approximately 3.0 percent to the national production of barley growing area. This crop requires an air temperature of 12 °C to 16 °C during the growing stage and 30 °C to 32 °C at maturity (Singh *et al.* 2019) [10]. This crop is extremely sensitive to frost at all growth stages. This crop's yield is greatly affected by the occurrence of frost during the flowering stage. Barley has an exceptionally high drought tolerance. Rainfall, temperature, and radiation are significant meteorological variables that affect all phases of plant growth. In arid and semi-arid regions, solar radiation is typically not a limiting factor for crop production. Barley is a long-day photosensitive and thermosensitive plant. Solar radiation absorption and its efficiency play a significant role in the production of dry matter. The study of micrometeorological processes in experimental problems of agrometeorological significance has substantially increased the application of the physical processes that regulate the natural environment of crop plants.

The crop-weather relations, growth and yield of barley crop were affected by differently growing environment because barley varieties have divergence for morphological, physiological and yield potential (Poudyal *et al.* 2019; Chaudhary *et al.* 2017; Green *et al*., 1985; Singh *et al*. 2012) [7, 2, 4, 9].

Therefore, this research has been planned to investigate the effect of growing environment cultivars and interaction effects on crop-weather relationships, growth and yield of barley under semi-arid conditions of Hisar. In agriculture, correlation analysis is a statistical evaluation technique used to strengthen the relationship between crop and weather parameters that are numerically measured using continuous variables (e.g. plant height, dry weight, temperature, humidity and rainfall). This type of analysis is helpful for establishing potential relationships between variables (Panse and Sukhatme, 1985) [6] and determining the cause and effect of a particular cultivar in a specified environment.

2. Materials and Methods

In order to evaluate the weather relationship and effect on yield and yield attributed of the barley crop under the various growing environments at Hisar condition to countrified the weather-crop growth parameters. As the effect of different growing environments on barley yield" a field experiment, conducted at adjacent to the agromet observatory (Lat. 29°10' N, Longitude-76° 45' E and altitude 215 meters AMSL) University Research Farm, Department of Agricultural Meteorology, CCS HAU, Hisar during *rabi* season of 2019-2020. The main characteristics of climate in Hisar are dryness, extreme of temperature and scanty rainfall with very hot summers and relatively cool winters. The recent trend of an average annual rainfall of was analysed in the experimental region is 473 mm (1980 to 2019) along with 31 rainy days and having very unevenly distributed. Soils were sandy loam in texture and contain some amount of calcium carbonate in its profile. Chemical analysis of soil sample indicate that the soil of experimental site was low in organic carbon having value (0.43%) and nitrogen (162kg ha^{-1}), medium in phosphorus (25kgha^{-1}) and rich in potassium (321kg ha^{-1}) and slightly alkaline in reaction having pH 8.1.The experiment was comprised of four sowing dates as factor (A) namely (D1) -15th Nov., (D2) – 30th Nov., (D3) – 15th Dec. and (D4) – 30th Dec., comprising four different cultivars factor (B) *viz*. (V1)- BH 393, (V2)-BH 902, (V3)- BH 946 and (V4)-BH 885 in factorial RBD design with three replications. The inter row spacing was 22.5 cm and gross plot of size 4.0 m × 3.6 m and net plot of size 3.0 m× 2.6 m. Five randomly plants was selected, from destructive sampling were used to record the growth and development at CRI, Tillering, Jointing, Booting, Anthesis, Milking, Dough and Physiological maturity stages. Yield attributing characters were recorded at the time of crop maturity. Data collected during the study were statistically analyzed by using the technique of analysis of variance (ANOVA) as applicable to Split plot design (Gomez and Gomez, 1984) [3]. Different Agro-meteorological indices such as Growing degree days (GDD), Helio-thermal unit (HTU), Photo-thermal unit (PTU), were calculated for conforming period by using various weather parameters *viz*., maximum temperature (Tmax, °C), minimum temperature (Tmin, °C), actual bright sunshine hours (BSS) and maximum possible sunshine hours (hr/day) under Hisar conditions. Thermal use efficiency (TUE) and Radiation use efficiency (RUE) were calculated by using accumulated biomass, accumulated heat units and intercepted photosynthetic active radiation (iPAR).

3. Result and Discussion

In order to be analysis in depth of relationship under prevailed weather condition under various growing environment to determine the relationships between agronomic and meteorological parameters in barley. The existing relationship were influenced and utilized under complete the life cycle of crop and also attain the various phenophases with optimum assimilation rate. Foggy weather and frequent western disturbance will be supportive residual moisture of the crop and lowering the water demand as received the low intensity of intercepted photosynthetic radiation (MJ/m2/day) and during barley growing season noticed the higher diffuse radiation intercepted. The distinguished the efficient growth, development and productivity of barley crop. The correlation coefficient was calculated by dividing the sum of the product of deviations from the mean by the square root of the product of sum of squares of deviations from the respective mean of the two variables and its significance was tested at 5% levels of significance.

Yield of this crop was resultant of many components which when modified, had direct influence on the productivity of crop in term of economical and biological yield. Optimum weather condition was maintained the grain and straw harvest ratio under different growing environment of barley crop. The yield of any crop species depends upon the source-sink relationship and is the collective function of various growth parameters and yield attributing characters *viz.,* number of effective tillers/m^2, spike length (cm), number of spikelets/spike, number of grains/spike, test weight or 1000-grain weight (g), grain yield (q/ha), biological yield (q/ha), straw yield (q/ha) and harvest index (%). During vegetative and reproductive phases of plants partitioning of the dry matter is affected by the environmental change during crop growth because of different dates of sowing. The late sown crop was drastically affected during the reproductive phase because of supra optimal higher temperature stress *i.e.* higher maximum and minimum temperature, which lead to shortening of crop duration resulting due to forced maturity. Lower air temperature cause delay in seedling emergence and higher air temperature during reproductive phase with shorter duration ultimately leads to forced maturity resulting in reduction of yield attributes and yield. Among the yield and yield attributing characters, spike weight (g), number of spikelets/ spike, number of grains per spike, test weight (g), grain yield (q/ha), biological yield (q/ha), and straw yield (q/ha), were found higher in D1 under varying growing environments due to higher leaf area index and thus crop sown on 1st fortnight of November accumulated greater dry matter as compared to others (Alam *et al*., 2007) [1]. Harvest index varied unsystematically with varying dates of sowing. The results were in conformity with the findings (Rao and Wattal, 1986) [8]. Among varying growing environments, D1 observed higher grain (48.96 qha^{-1}) and biological yields (143.51 qha^{-1}) and were lowest in D4 due to shorter growing period reduced the rate of floral development or higher temperature during milking stage reduced the kernel weight and hence resulted in lower grain yield. Among varieties, grain yield (q/ha), biological yield (q/ha) and straw yield (q/ha) were highest in variety BH 393 while lowest in variety BH 885 (Table 1). The highest grain and biological (48.29 and 129.95 qha^{-1}) were observed in variety BH 393 (Table 1). The reason was being better partitioning of biomass to economic sink and higher biomass production and higher grains/spike in variety BH 393 resulted to more grain and biological yield as compared to variety BH 885.

Table 1: Effect of different growing environment and varieties over yield and yield components in Barley

Treatments	Spike length (cm)	Awn length (cm)	Spikelets/ spike	Grains/ spike	Spike weight (g)	Test weight (g)	Grain Yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
Date of sowing (A)									
D1(15th Nov)	16.5	8.3	45	44	2.85	42.94	48.96	94.55	33.93
D2(30th Nov)	17.2	9.1	44	42	2.60	40.62	43.99	83.76	34.36
D3(15th Dec)	17.7	9.9	42	40	2.45	39.60	48.40	72.27	40.20
D4(30th Dec)	17.6	10.0	42	41	2.28	41.45	43.18	61.17	41.71
SE(m)	0.21	0.15	0.88	0.79	0.06	0.88	2.91	2.99	1.98
CD (A)	0.61	0.43	2.56	2.29	0.15	NS	NS	8.68	5.73
Varieties (B)									
V1: BH393	17.2	10.1	47	45	2.62	37.89	48.29	81.66	37.26
V2: BH902	18.7	10.6	52	50	3.51	43.18	41.91	84.73	33.09
V3: BH946	15.8	9.03	48	47	2.64	40.06	47.63	74.17	39.62
V4: BH885	17.3	10.4	25	25	1.41	43.48	46.69	71.19	40.23
SE(m)	0.21	0.15	0.88	0.79	0.06	0.88	2.91	2.99	1.98
CD (B)	0.61	0.43	2.56	2.29	0.15	2.55	NS	8.68	NS

3.1 Weather-relationship of plant parameters with agrometeorological indices

Plant height-the weather influenced the plant height and agrometeorological indices shows significant positive correlation at CRI with GDD,HTU and PTU, at tillering with TUE and RUE, at jointing with GDD and PTU, at anthesis with GDD, HTU and PTU, at dough with TUE and RUE (Table 2). The temperature-heat derivative product was found significant negative correlation between plant height and agrometeorological indices at booting with GDD and PTU and at dough with GDD, HTU and PTU. Leaf area index results reveal that the relationship between LAI and agrometeorological indices shows positive correlation of LAI at CRI with GDD, HTU and PTU, at booting with TUE and RUE and at dough with GDD, HTU, and PTU (Table 2). It was found that the significant negative correlation between LAI and agrometeorological indices at booting with HTU and PTU and at dough with TUE and RUE. Correlation studies between CCI and agrometeorological indices are mostly negatively correlated (Table 3). Significant positive correlation of CCI at anthesis with TUE and RUE. Significant negative correlation was found with the CCI at jointing, TUE and RUE, at booting stage along with PTU and at anthesis with HTU and PTU. Total Dry matter and agrometeorological indices are significant positive at booting, anthesis, milking, dough and PM with TUE and RUE and significant negative at anthesis, milking, dough and PM (except with GDD) with GDD, HTU and PTU (Table 3). A significant positive correlation was found with the total dry matter at jointing with RUE and significant negative at booting stage with HTU.

Table 2: Correlation coefficient of plant height (cm) and LAI with agrometeorological indices

Growth phase	Plant height					Leaf area index				
	GDD	HTU	PTU	TUE	RUE	GDD	HTU	PTU	TUE	RUE
CRI	0.84*	0.81*	0.85*	-0.46	-0.08	0.54*	0.50*	0.53*	-0.46	-0.46
Tillering	0.06	-0.02	0.06	0.50*	0.60*	-0.40	-0.05	-0.39	-0.03	-0.35
Jointing	0.57*	0.34	0.56*	-0.09	0.16	-0.12	-0.12	-0.13	0.15	0.13
Booting	-0.54*	-0.35	-0.52*	0.19	0.07	-0.47	-0.57*	-0.54*	0.66*	0.60*
Anthesis	0.68*	0.67*	0.66*	-0.43	-0.43	0.33	0.34	0.36	-0.27	-0.22
Milking	-0.18	-0.25	-0.23	0.44	0.43	0.48	0.38	0.45	-0.43	-0.43
Dough	-0.51*	-0.53*	-0.53*	0.62*	0.62*	0.82*	0.75*	0.79*	-0.71*	-0.66*
PM	-0.03	-0.35	-0.18	0.46	0.44					
Whereas, GDD-Growing degree day (°C day), HTU-Helio thermal unit (°C day hr.), PTU-Photothermal unit (°C day hr.), Thermal use efficiency (kg/ha/°C day hr.), RUE-Radiation use efficiency (kg/ha/MJ)										

*Significance at P = 0.05

Table 3: Correlation of plant CCI and Plant Dry Matter with agrometeorological indices

Growth phase	Plant CCI					Plant Dry Matter				
	GDD	HTU	PTU	TUE	RUE	GDD	HTU	PTU	TUE	RUE
CRI	-0.07	-0.05	-0.06	0.24	0.19	0.29	0.25	0.29	0.08	0.34
Tillering	-0.37	-0.29	-0.37	0.44	0.37	0.44	0.11	0.43	-0.06	0.18
Jointing	0.00	0.46	0.05	-0.54*	-0.56*	0.34	-0.31	0.29	0.48	0.61*
Booting	-0.70*	-0.38	-0.68*	0.42	0.25	-0.23	-0.76*	-0.35	0.68*	0.76*
Anthesis	-0.49	-0.54*	-0.50*	0.57*	0.61*	-0.76*	-0.76*	-0.78*	0.71*	0.69*
Milking	-0.07	-0.09	-0.06	0.11	0.12	-0.73*	-0.76*	-0.76*	0.72*	0.70*
Dough	0.23	0.13	0.21	-0.07	-0.05	-0.79*	-0.82*	-0.81*	0.71*	0.70*
PM	-0.04	-0.05	-0.05	-0.04	-0.08	-0.28	-0.76*	-0.52*	0.71*	0.66*

*Significance at P = 0.05

3.2 Correlation of agrometeorological indices with weather parameters

Significant positive correlation of GDD with all the weather parameters at all stages except Tmax at tillering, jointing, and Booting stage (Table 4), RHm at CRI, tillering, anthesis, milking, dough and PM, RHe at CRI, dough and PM, WS at CRI, milking and dough, SSH at tillering, jointing, booting, anthesis and milking, PE at jointing only and rainfall at dough and PM stages are negatively correlated with GDD. Significant positive correlation of HTU with weather parameters at all crop stages from CRI to PM except RHm at all stages, RHe at CRI, tillering, jointing, dough and PM, WS at CRI, milking and dough, SSH at booting, anthesis and milking, and rainfall at dough and PM stages are negatively correlated with HTU(Table 5). Photothermal unit (°C day hr.) is positive correlation of PTU at CRI with Tmax, Tmin, PE and rainfall, at tillering with Tmin, and RHe, at jointing with Tmin, at Booting with Tmin, RHe and rainfall, at anthesis, milking, dough and PM with Tmax, Tmin and PE and at PM with WS and SSH. Correlation of PTU with weather parameters are significant negatively correlated at CRI with RHm, RHe, and WS, at Booting and anthesis with SSH, at dough with RHm, RHe and WS and at PM with RHm and rainfall (Table 6). Radiation use efficiency (kg/ha/MJ) relationship had evaluated to prevailed weather parameters are mostly negative. The significant positive correlation at jointing, dough and PM with RHm and RHe, at booting stage with RHm, at anthesis stage with SSH and at PM with rainfall (Table 7). Significant negative correlation are at tillering with Tmax, PE and rainfall, at jointing, anthesis, milking, dough and PM with Tmax, Tmin and PE, at jointing, dough and PM with SSH, at jointing and booting with WS and rainfall and at anthesis with rainfall. TUE are mostly negatively correlated. significant positive correlation are found at jointing with RHm and RHe, at anthesis with SSH, at dough with RHm, RHe and WS, at PM with RHm, RHe and rainfall (Table 8).Significant negative correlation are found at all stages with Tmax, Tmin and with PE except at tillering stage, at CRI with rainfall also, at jointing with WS, SSH and rainfall also, at booting with WS and rainfall also and at dough and Pm with SSH also.

Table 4: Correlation coefficient of growing degree day (GDD) with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
CRI	0.92*	0.95*	-0.83*	-0.57*	-0.80*	0.42	0.95*	0.96*
Tillering	-0.16	0.70*	-0.13	0.59*	0.19	-0.45	0.04	0.22
Jointing	-0.07	0.50*	0.03	0.48	0.36	-0.49	-0.02	0.14
Booting	-0.14	0.48	0.32	0.68*	0.14	-0.66*	0.20	0.73*
Anthesis	0.90*	0.89*	-0.45	0.36	0.32	-0.80	0.92	0.35
Milking	0.65*	0.77*	-0.39	0.19	-0.43	-0.42	0.74	0.05
Dough	0.96*	0.89*	-0.96*	-0.96*	-0.59*	0.66*	0.97*	-0.42
PM	0.36	0.54*	-0.36	-0.15	0.58*	0.26	0.49	-0.24
Tmax-Maximum temperature (°C), Tmin-Minimum temperature (°C), RHm -Morning relative humidity, & RHe-Evening relative humidity (%), WS -Wind speed (km/hr), BSS-Bright sun shine hour (hr/day), PE-Pan evaporation (mm/day) and RF- Rainfall(mm/day)								

*Significance at P = 0.05

Table 5: Correlation coefficient of HTU with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
CRI	0.90*	0.91*	-0.76*	-0.52*	-0.80*	0.47	0.94*	0.98*
Tillering	0.42	0.30	-0.66*	-0.04	0.19	0.19	0.63*	0.59*
Jointing	0.81*	0.96*	-0.78*	-0.46	0.96*	0.49	0.83*	0.70*
Booting	0.56*	0.86*	-0.38	0.29	0.51*	-0.15	0.80*	0.89*
Anthesis	0.92*	0.95*	-0.38	0.54*	0.47	-0.85*	0.94*	0.45
Milking	0.69*	0.82*	-0.37	0.21	-0.44	-0.46	0.79*	0.08
Dough	0.97*	0.89*	-0.94*	-0.96*	-0.73*	0.65*	0.98*	-0.53*
PM	0.88*	0.93*	-0.86*	-0.71*	0.51*	0.80*	0.93*	-0.73*

*Significance at P = 0.05

Table 6: Correlation coefficient of PTU with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
CRI	0.92*	0.95*	-0.83*	-0.57*	-0.80*	0.43	0.95*	0.97*
Tillering	-0.14	0.70*	-0.15	0.57*	0.19	-0.42	0.07	0.25
Jointing	0.05	0.60*	-0.08	0.38	0.46	-0.39	0.09	0.23
Booting	-0.01	0.59*	0.20	0.66*	0.24	-0.61*	0.33	0.80*
Anthesis	0.90*	0.90*	-0.45	0.38	0.31	-0.82*	0.93*	0.36
Milking	0.69*	0.80*	-0.40	0.17	-0.45	-0.43	0.77*	0.04
Dough	0.96*	0.89*	-0.95*	-0.96*	-0.64*	0.66*	0.98*	-0.44
PM	0.63*	0.76*	-0.63*	-0.43	0.57*	0.54*	0.73*	-0.50*

*Significance at P = 0.05

Table 7: Correlation coefficient of RUE with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
CRI	-0.19	-0.22	0.27	0.18	0.22	0.00	-0.25	-0.19
Tillering	-0.60*	-0.09	0.31	0.29	-0.42	-0.47	-0.59*	-0.68*
Jointing	-0.86*	-0.52*	0.77*	0.86*	-0.64*	-0.91*	-0.84*	-0.57*
Booting	-0.77*	-0.86*	0.58*	-0.06	-0.64*	-0.12	-0.88*	-0.70*
Anthesis	-0.79*	-0.82*	0.37	-0.37	-0.25	0.80*	-0.86*	-0.51*
Milking	-0.80*	-0.79*	0.46	-0.06	0.41	0.34	-0.82*	0.20
Dough	-0.88*	-0.88*	0.89*	0.84*	0.67*	-0.51*	-0.89*	0.36
PM	-0.75*	-0.71*	0.71*	0.65*	-0.20	-0.79*	-0.77*	0.78*

*Significance at P = 0.05

Table 8: Correlation coefficient of TUE with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
CRI	-0.55*	-0.60*	0.41	0.19	0.48	-0.21	-0.59*	-0.69*
Tillering	-0.32	-0.31	0.39	0.01	-0.41	-0.14	-0.43	-0.46
Jointing	-0.85*	-0.75*	0.78*	0.68*	-0.81*	-0.73*	-0.85*	-0.63*
Booting	-0.55*	-0.84*	0.36	-0.28	-0.56	0.13	-0.76*	-0.80*
Anthesis	-0.80*	-0.80*	0.38	-0.31	-0.19	0.80	-0.86*	-0.43
Milking	-0.80*	-0.77*	0.48	-0.04	0.43	0.31	-0.81*	0.20
Dough	-0.90*	-0.89*	0.92*	0.86*	0.65*	-0.52*	-0.90*	0.36
PM	-0.79*	-0.80*	0.76*	0.65*	-0.36	-0.79*	-0.84*	0.76*

*Significance at P = 0.05

3.3 Correlation of yield and yield attributes with weather parameters

Countrified the existing association with yield attributes and weather parameters are mostly negative (Table 9). Only straw yield and awn length shows the significant correlation with weather parameters. RHm and RHe show the significant positive correlation with straw yield whereas all other weather parameters show significant negative correlation with straw yield. All other parameter except RHm and RHe shows the significant positive correlation with awn length (except rainfall). RHm and RHe shows the significant negative correlation with awn length.

Table 9: Correlation of yield and yield attributes with weather parameters of Barley crop

Growth phase	Weather parameters							
	Tmax	Tmin	RHm	RHe	WS	SSH	PE	Rain
Effective tillers/m2	0.13	0.12	-0.13	-0.11	0.15	0.21	0.19	0.36
Test weight	0.05	0.06	-0.08	-0.07	-0.09	-0.06	-0.02	-0.20
Grain yield	-0.28	-0.28	0.28	0.27	-0.24	-0.26	-0.28	-0.25
Straw yield	-0.76*	-0.76*	0.76*	0.74*	-0.79*	-0.81*	-0.81*	-0.68*
Harvest index	0.43	0.43	-0.43	-0.42	0.46	0.47	0.46	0.38
Spikelets/spike	-0.16	-0.18	0.16	0.13	-0.10	-0.13	-0.16	-0.17
Grains/spike	-0.16	-0.17	0.17	0.13	-0.09	-0.13	-0.16	-0.14
Awn length	0.58*	0.58*	-0.60*	-0.57*	0.66*	0.64*	0.66*	0.34
Spike length	0.28	0.28	-0.30	-0.28	0.34	0.32	0.33	0.06
Spike weight	-0.27	-0.27	0.27	0.25	-0.22	-0.27	-0.28	-0.31

*Significance at P = 0.05

4. Conclusion

The 15th November sown crop better utilization and consumed the thermal heat energy during attained the different phenophase and complete their life cycle of crop. First growing environment have influenced the optimum weather conditions and significant coefficient. The first growing environment crop analysed overall growth, yield, and yield contributing attributes, and variety BH 393(V1) had better overall grain and biological yield. During various crop growth stages, correlation analysis shows that plant height or LAI has a stronger association with GDD, HTU, and PTU than TUE or RUE. Total dry matter shows higher significant correlation after Booting with all agrometeorological indices; negative association with GDD, HTU, and PTU or positive association with RUE and TUE. Along with agrometeorological indices i.e. temperature and day length derivative which had a higher significant positive association with maximum & minimum temperature, than all other weather parameters, while RUE or TUE had a higher significant negative association. With respect to yield and yield contributing factors straw yield showed the higher correlation coefficient that showed the better association with weather parameter than awn length. These characteristics could be used for evaluation of crop-weather relationships in barley under different growing environments and can be able to develop the site specific model of future prediction i.e. dependent and independent variable (with inclusion of biotic and abiotic parameters at different crop growing phenophases).

5. References

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