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Correlation Study in Soybean (*Glycine max*. [L] Mirrll) with Response to Prevailing Weather Parameter, Agro-meteorological Indices to Seed and Stover Yield at Anand

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Abstract: Soybean (*Glycine max.* [L] Mirrll.) is one of the leguminous pulse and oil seed crops in tropical and sub-tropical regions of India. It is a short duration and thermo-sensitive crop and its response to yield varies with variety and temperature successfully grown in *kharif* as well as in summer where adequate irrigation facilities are available. To understand the correlation between weather parameter and soybean yield as well as the agro-meteorological indices and soybean yield was determined Correlation coefficients also revealed that the vapour pressure play important role in deciding the final seed yield. Seed yield had negative correlation between after noon vapour pressure (VP_2) and mean vapour pressure (VP mean) during the phenophase P_5 (First flowering to 50 percent flowering stage). The favorable impact of vapour pressure on seed yield might be ascribed the lower evaporative demand and there by more vegetative growth and consequently more seed yield. The higher relative humidity during the flowering phase might have to help in proper seed setting by overcoming the pollen desiccation and thereby in good seed yields and lower temperature during the flowering period increased the productivity of soybean. The fact is that the positive correlation of seed yield with these agro-meteorology indices could not necessarily be taken to mean the thermal regime with higher prevailing temperatures which contribute the positive correlation with the seed yield of soybean. The question of thermal indices such as GDD, PTU and HTU as used in the present study needs to be viewed not only in terms of the high or low values of the prevailing temperature during the particular phenophases, but also in terms of temperature taken in conjunction with the duration of the particular phase.

Key words: Correlation · Prevailing weather · Agro-indices · GDD · PTU · HTU

INTRODUCTION

The productivity of the crop mainly depends upon the climatic requirement of the particular crop like soybean which can grow in the wide range of climatic conditions, but its productivity is largely depends on the prevailing weather conditions throughout the life cycle of the soybean crop. Further, the different weather parameters affect growth and development of crop differently. Therefore, it was contemplated to have an insight on the effect of different weather parameters and thereby agro-meteorological indices for the production of soybean crop and to identify the critical phenophases at which soybean crop was most sensitive to the effect of particular weather parameters.

MATERIALS AND METHODS

Correlation studies of grain and total biomass yield with relation to various weather variables/parameter as well as agrometeorological indices were carried out with phenophasewise of soybean with the help of methodology described by the Gomez and Gomez [1] for the crop sown on the first (D_1), Second (D_2) and Third date (D_3) of sowing. The meteorological parameters of mean values of of maximum temperature (T max.), minimum temperature (T min.), average temperature (T mean), morning time vapour pressure (VP mean), bright sunshine hours (BSS) and accumulated photosynthetically active radiation (Acc.PAR) was used.

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RESULTS AND DISCUSSION

The assessment of seed yield and Stover yield was made in relation to weather parameters and agro-meteorological indices viz., evaporation (Eo), rainfall (RF), bright sunshine hours (BSS), maximum (T max.), minimum (T min.) and mean (T mean) temperatures, morning (RH_1), afternoon (RH_2)and mean (RH mean) relative humidities and agro-meteorological indices like accumulated (Acu. GDD), accumulated photo thermal unit (Accu. PTU) and accumulated helio-thermal unit (Accu. HTU). The performance of seed and Stover yield was assessed one by one phase wise in the terms of seed yield and total biomass with the corresponding weather parameters and agro-meteorological indices Shah and Hanta [2].

Seed and Stover yield: The correlation coefficient between seed yields and weather parameters as well as between the agro-meteorological indices are presented in Table 1. The results induced that the seed yield and morning relative humidity (RH_1) was significant and negatively correlated with the phenophase P_1 (Emergence to unifoliate), but importance was not more due to initial short phases of the crop. There was significant positive correlations of seed yield with the maximum temperature (Tmax.), morning vapour pressure (VP_1) in the phenophases P_2 (Unifoliate to first branching), the bright sunshine hours (BSS), maximum temperature (T max.), minimum temperature (T min.), mean temperature (T mean) and morning vapour pressure (VP_1) was significant and rainfall (RF), afternoon relative humidity (RH_2), mean relative humidity (RH mean) and mean vapour pressure (VP mean) significant negative correlation in the P_3 (First branching to flower bud induction) phenophased. The evaporation (Ep), bright sunshine hours (BSS), maximum temperature (T max.), minimum temperature (T min.), mean temperature (T mean) result was significantly positive and rainfall (RF), afternoon relative humidity (RH_2), mean relative humidity (RH mean), afternoon vapour pressure, mean vapour pressure (VP mean) was negative significant correlated in the P_4 (First flower bud induction to first flower) phenophase. The evaporation (Ep), bright sunshine hours (BSS), maximum temperature (T max.), minimum temperature (T min.) and mean temperature was positively correlated in the P_8 (50 per cent podding to end of leaf) phenophases of soybean, evaporation significant positive and minimum temperature (T min.), mean temperature (T mean), morning relative humidity (RH_1), morning vapour pressure (VP_1), afternoon vapour pressure (VP_2) and mean vapour pressure (VP mean) was significant negative correlated in the P_9 (End of leaf to dough stage) phenophases.

Table 1: Correlation Coefficients Between Average Weather Parameters and Seed Yield of Soybean at Different Phenophases

Weather parameters/ agro-met. Indices	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}
EP	0.960	-0.100	-0.244	0.679*	0.327	-0.045	0.701	0.074*	0.708*	0.695
BSS	0.299	-0.239	-0.588*	0.688*	-0.198	-0.121	0.707	0.688*	0.553	0.726
RF	0.710	0.230	-0.705*	-0.689*	0.257	-0.430	0.704	0.331	0.190	-0.707
T max.	0.046	0.701*	0.676*	0.637*	-0.105	0.088	0.653	0.701*	0.504	0.664
T min.	0.25	0.047	0.704*	0.585*	0.524	-0.236	0.073	-0.12	-0.672*	-0.712
T mean	0.29	0.353	0.688*	0.672*	0.014	0.056	0.626	0.646*	-0.692*	-0.679
RH_1	-0.261	0.11	-0.645	-0.632	-0.629	-0.337	-0.682	0.375	-0.682*	-0.705
RH_2	-0.116	-0.040	-0.645*	-0.645*	0.293	-0.236	-0.701	-0.430	-0.540	-0.701
RH mean	-0.158	-0.020	-0.645*	-0.645*	0.229	-0.291	-0.706	-0.249	-0.568	-0.707
VP_1	-0.628*	0.680*	0.702*	0.537	-0.174	-0.383	-0.447	0.356	-0.642*	-0.707
VP_2	-0.101	0.345	-0.640	-0.630*	0.688	-0.481	-0.699	0.190	-0.582*	-0.707
VP mean	-0.156	0.443	-0.631*	-0.659*	0.619	-0.441	-0.661	0.257	-0.605*	-0.707
Acc. GDD	-0.648*	0.010	0.095	0.651*	0.615	0.318	-0.620	0.605	0.377	0.706*
Acc. PTU	0.567	-0.030	0.094	0.651*	0.618	0.348	0.650	0.599	0.421	0.700*
Acc. HTU	0.574	0.456	0.205	0.641*	0.615	0.685*	0.245	0.609	0.701*	0.525

P_1 = Emergence to unifoliate; P_2 = First unifoliate to first branching; P_3 = First branching to flower bud induction
P_4 = Flower bud induction to first flower; P_5 = First flower to 50 percent flower; P_6 = 50 percent flower to first pod
P_7 = First pod to 50 percent podding; P_8 = 50 percent podding to end of leaf; P_9 = End of leaf to dough stage
P_{10} = Dough to physiological maturity

The result also indicated that the lower temperatures at the time of flowering bud initiation and hence the increase in the period of the crop production. These results are in close agreement with the finding of Whiteman *et al*. [3] who has reported that both the low and high temperatures delayed the flowering and benefited in crop yield. The results also indicated that evaporation (Ep), bright sunshine hours (BSS), maximum temperature (T max.), mean temperature (T mean) in P_8 phase played an important role in good seed yield during the *kharif* season. The higher relative humidity during the flowering phase might have to help in proper seed setting by the overcoming the pollen desiccation and thereby in good seed yields. These results are in confirmation with the earlier findings of Singh *et al.* [4] for the most of the dry land crops at Hissar.

Agro-meteorological indices like accumulated growing degree day (GDD), accumulated photo thermal unit (PTU), which exhibited significant positive correlation with the seed yield during the phenophase P_4 (Flower bud induction to first flower). The similar results in case of thermal unit (GDD) have been reported by Dhingra *et al.* [5], Itawa [6], Hundal *et al*. [7], Hundal and Kingra [8].

The results also revealed that the seed yield had the positive correlation with thermal indices like accumulated growing degree day (GDD), accumulated photothermal unit (PTU) and accumulated helio thermal unit (HTU) in the P_4 (Flower bud induction to first flower) phenophase. This was in contrast with the negative correlation of seed yield with maximum temperature (T max.), minimum temperature (T min.) and mean temperature that prevailed during the said phases despite of the fact that the former indices are based on the latter parameters. In the present study, the thermal regimes as expressed in terms of accumulation was associated with the duration of phenophases of soybean crop.

CONCLUSION

The quantification of heat use efficiency in terms of dry matter production per unit growing degree day of soybean, the heat use efficiency for dry matter production for the overall growth period was found more in the D_2 (0.78 kg ha^{-1} °C) and D_3 (0.68 kg ha^{-1} °C) treatment than the D_1 (0.29 kg ha^{-1} °C) in the seed yield. Ascending order was noticed in case of stover yield. Correlation coefficient also played the role in deciding the final seed yield. Agro-meteorological indices like accumulated growing degree day (GDD), accumulated photothermal unit (PTU) exhibited significant positive correlation with the yield during the phenophases P_4 (flower bud initiation to first flower).

Our findings suggest that the delaying the sowing dates of soybean crop should be able to mitigate the detrimental effect of thermal stress due to prevailing weather condition and agro-meteorological indices, also soybean sowing in the month of June could be favorable for the higher yield particularly at Middle Gujarat , India region. However, the proposed shift the date of sowing of soybean grain production from current main season i. e. June to a second season may second week of July for the positive correlation with agro-meteorological indices and cultural practices, may would require additional cultural practices and management in these region.

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