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***Short Comminucation***

# Predictive models for safflower aphid infestation for the scarcity zone of Maharashtra

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Maharashtra state is the largest producer of safflower having 1.23 lakh ha (50.83 %) area with production of 0.67 lakh tones (55.37 %) and productivity 545 kg ha$^{-1}$ (2011-12). In spite of its utility and importance the fact remains that area and production of safflower is declining drastically in India in general and Maharashtra state specific because of several biotic and abiotic stresses.

Among the biotic stresses, safflower aphid (*Uroleucon compositae* Theobald) plays a major role (Akashe *et al.,* 1999) in reducing the seed yields particularly under delayed sowing condition and in case of non-spiny varieties. Due to aphid infestation, losses were to the extent of 20 to 80 % have been reported (Singh *et al.*, 2000). Srinivas *et al.* (2012) studied the response of aphids to climate change and reported that the safflower aphid is economically important pest in India which however, is more sensitive to weather factors particularly temperature. Akashe *et al.* (2013) also developed weather based forewarning models for safflower aphid (*Uroleucon compositae* T.) in the scarcity zone of Maharashtra and proposed equations to forewarn the incidence of safflower aphid using five years data (2007-08 to 2011-12). Most of the models developed and available in the literature have not been validated, hence their usefulness is questioned. In the present investigation attempt has been made here to develop forewarning model for safflower aphid using 10 years data (2002 to 2011) and validate them with two years (2012 and 2013) independent data.

The aphid infestation data collected from the experiments conducted at the research farm of All India Co-ordinated Research Project on Safflower, ZARS, Solapur (MS), India (75°56' l, 17°41' N) for 12 years (2002 to 2013) have been used in the study. Ten years data (2002 to 2011) was used for development of model while two years (2012 and 2013) was used for validation of the model. The weather data for the corresponding period was obtained from All India Co-ordinated Research Project on Agro meteorology, ZARS, Solapur (MS), India. The details of crop/variety/ method of observation and analysis are as described by Akashe *et al.* (2013).

Weekly weather parameters $T_{Max,}$ $T_{Min}$, RH-I, RH-II and rainfall were correlated with aphid population. The linear regression equations were developed for both sowing conditions and two varieties separately for the prediction of aphid population. Only significant weather parameters were considered for the development of equations/predictive models.

The results revealed that the aphid population was negatively correlated with maximum and minimum temperature under both the sowing conditions on both the cultivars, while it was positively correlated with relative humidity-II (evening) except on normal sown A-1 (Table 1). Minimum and maximum temperatures contributed significantly for the aphid incidence and its further spread under normal and late sowing situations as well as for cultivating either spiny (tolerant) and/or non-spiny (susceptible) cultivars of safflower.

Ten years data (2002-03 to 2011-12) on aphid populations were used in the development of forewarn models through regression techniques. The linear regression predictive model equations were developed for two sowing conditions i. e. normal and late (Table 2). Coefficient of determination ($R^2$) was improved significantly when linear regression models were fitted for predicting the aphid incidence. By employing step down linear regression models, the incidence of aphids on safflower can be predicted with an accuracy of 94 to 95 % under normal and late sowing conditions for tolerant (A-1) and susceptible (CO-1) varieties.

Observed and predicted values of aphids on safflower are also calculated for fitting the ETL with an exposure period considered to undertake spray schedule. The standardized residual values estimated based on deviation

**Table 1:** Correlation coefficient (r values) between aphid population and weather parameters during 2002-03 to 2011-12 (Average of ten years).

| Parameter | Cv. A-1 | | Cv. CO-1 | |
|---|---|---|---|---|
| | Normal | Late | Normal | Late |
| $T_{max}$ | -0.91** | -0.90** | -0.92** | -0.91** |
| $T_{min}$ | -0.84** | -0.82** | -0.80** | -0.81** |
| RH-II | -0.11 | 0.04 | 0.07 | 0.08 |
| $R^2$ | 0.95 | 0.94 | 0.95 | 0.95 |

*Table value r at 5 % = 0.55
** Table value r at 1 % = 0.68

**Table 2:** Predictive models developed for safflower aphid incidence.

| Sowing Time | Variety | Prediction model | $R^2$ |
|---|---|---|---|
| Normal | A-1 | APH= 1002.17 -29.70 *$T_{max}$ -13.49 *$T_{min}$ + 4.64 *RH-II (1). | 0.95** |
| | CO-1 | APH= 1333.54 -44.33 *$T_{max}$ -22.08 *$T_{min}$ + 11.90 *RH-II (2). | 0.95** |
| Late | A-1 | APH= 995.57 -32.28 *$T_{max}$ -18.67 *$T_{min}$ + 9.13 *RH-II (3). | 0.94** |
| | CO-1 | APH= 1450.41 -49.29 *$T_{max}$ -29.02 *$T_{min}$ + 15.92 *RH-II (4). | 0.95** |

Where, APH=Aphid population (in above equation), $T_{max=Max.\ Temp.}$, $T_{min=Min.\ Temp.}$, RH-II=Relative Humidity (Evening).

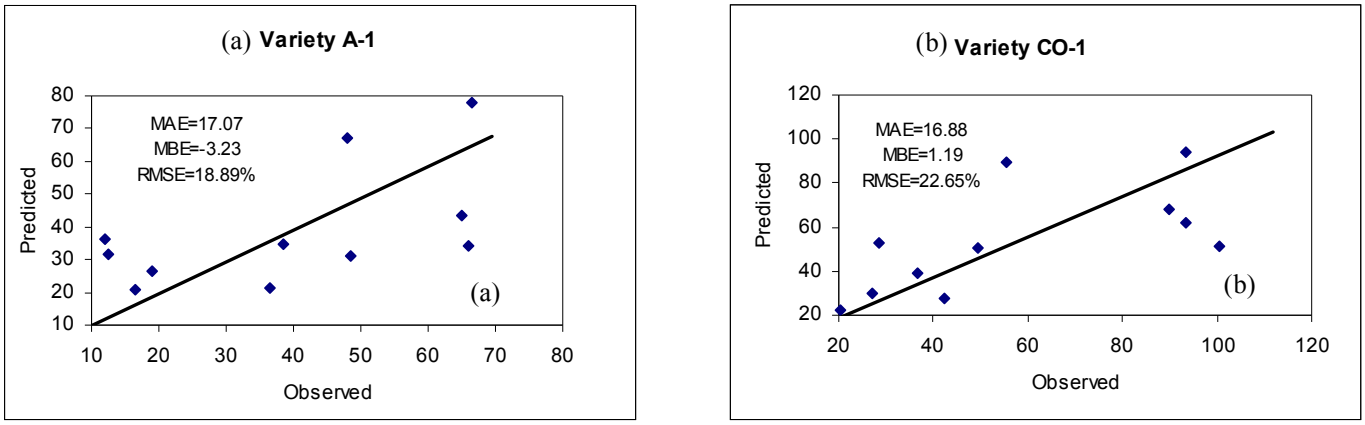


**Fig. 1:** Observed and predicted aphid population at Solapur (MS) in varieties (a) A-1 and (b) CO-1.

between observed and predicted aphids are less than 3.00 which indicated the suitability of models for aphid prediction irrespective of weather parameters. During both years (2012-13 and 2013-14) there were no significant differences between observed and predicted aphids which indicated the non-significant results. Hence, the linear regression equations developed are useful for aphid prediction (one week prior to the natural built up). The high $R^2$ values under linear regression models confirm the validity of the models in estimating the percent aphid index and graphical representation also. Srivastava and Prajapati (2012) validated the temperature based mustard aphid forewarning model of Chakravarti and Gautam (2002). Regression equation (1) was considered and adopted for aphid prediction on safflower which is already recommended for the purpose (Anon., 2014). The pest-weather model was validated satisfactorily (RMSE=18.89 & 22.65%, MAE=17.07 & 16.88, MBE=3.23 & 1.19) with independent two year data (2012 and

3013) on weather and safflower aphid population (Fig. 1). Pest-weather model clearly suggested the $T_{Max,}$ $T_{Min}$, and RH-II to be important weather parameters that influenced safflower aphid population at Solapur, Maharashtra.

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