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Effect of weather parameters on growth and yield of cucumber under different treatments

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Abstract
Field experiments were conducted during early summer season (January to April) of 2021 at Department of Entomology, VNMKV, Parbhani to study the "Influence of weather parameters on growth and yield of cucumber". The experiment was laid out in Randomized Block Design in eight treatments with three replications. The treatment was T_1 [Emamectin benzoate 5% SG], T_2 [Flubendamide 480% SC], T_3 [Spinosad 45% SC], T_4 [Cyantraniliprole 10% SC], T_5 [Novaluron 10% EC], T_6 [Lambda cyhalothrin 5% SC], T_7 [Chlorantraniliprole 18.5% SC] and T_8 [Untreated control. The weather conditions like temperature, humidity, wind speed, etc. affected on population of insect pest, growth and yield of cucumber. During entire study, meteorological instruments like Spectroradiometer, Green seeker, Pocket weather meter and soil thermometer were used to record weekly reading on daily basis.
Spectroradiometer was used to estimate vegetation indices such as NDVI, EVI, PAR, RVI, DVI and SAVI from the study plots. Simultaneously, Green seeker was also used to estimate NDVI from the same field. Whereas, Pocket weather meter were used to record weekly meteorological parameters (wind speed, temperature, humidity, thermal heat index, dew point and wet bulb temperature and soil temperature) was recorded using soil thermometer (5, 15 and 30 cm depth). The result of the present investigation indicated that the treatment T_4 [Cyantraniliprole 10% SC] was found to be superior in the flowering parameters such as days require to first flower (35.5 days) was found to be minimum of cucumber crop as compared to rest in treatments. In case of fruit parameters, the treatment T_4 [Cyantraniliprole 10% SC] was found with days require to 1st fruit (49.0 days), total number of fruits per plant (16.0), and weight of fruit per plant (3.72) of cucumber as compared to rest in treatments. In case of yield parameters, the treatment T_4 [Cyantraniliprole 10% SC] was found with days required to first harvest (56.0), weight of fruit per plant (3.72), yield Kg per plot (26.0) and yield Kg/ha (42472.3) of cucumber as compared to rest in treatments. The result of the present investigation indicated that, in case of spectral indices parameters such as EVI the treatment T_4 [Cyantraniliprole 10% SC] was found with EVI (0.80) of cucumber as compared to rest in treatments.
Hence, it was concluded that the use of T_4 (Cyantraniliprole 10% SC) as a best for increasing growth, yield, and spectral indices like NDVI of cucumber.

Keywords: Cucumber, EVI, green-seeker, NDVI, PAR, spectroradiometer, growth and yield

Introduction
Cucumber (*Cucumis sativus* L.,), often known as "Khira" is a widely grown creeping vine plant from the *Cucurbitaceae* family of gourds. It is a warm-weather cucurbitaceous vegetable crop grown in the Eastern area of India's new alluvial genetic zone. It is a member of the *Cucurbitaceae* family, genus Cucumis, and is native to the tropical regions of Southern Asia, where it has been cultivated for over 3000 years. Cucumber is grown primarily on almost every continent and many different types are traded on the global market. It is an important and commercially popular cucurbitaceous vegetable crop with high market demand. It is mostly farmed for its fruits in the tropics and subtropics of the world. The ripened fruits are used as a vegetable in salads or pickled cucumbers (Sumathi *et al*., 2008) [8-9].
Cucumber production in India is expected to reach 1603 million tonnes in 2019-20. After China, India is the world's second-largest producer of vegetables. Cucumber was grown on around 104 million hectares in India, yielding 1217.0 million tonnes (Anonymous, 2018). Cucumber production in Maharashtra reached 58.9 million tonnes in 2017-18 (National Horticulture Board, Indian Production of Cucumber). Temperatures between 20 °C and 30 °C during the day have little effect on production, whereas early production can be higher at higher temperatures up to 25 °C. Plants have imbalances over 30 °C, which have a direct impact on photosynthetic and respiration activities.

Frost damage is caused by the crucial temperature, which ranges from -12 °C to 1 °C (general plant wilting is difficult to recover). Using a double-covered vine type greenhouse to raise the temperature and improve the cucumber production system is useful. The maximum temperatures exceeding 40 °C causes growth to cessation. Because of the large surface area of its leaves, it demands a lot of humidity. The ideal relative humidity is 60-70% during the day and 70-90% at night. Excess moisture during the day, on the other hand, can reduce production by reducing the effects of transpiration and photosynthesis, although this is a rare occurrence. Condensation on the crop or dripping from the roof may cause fungal diseases in regions where the humidity level is above 90% so there is a saturated steam atmosphere. Similarly, a wet plant will start working later in the morning since the leaves will use the first energy available to evaporate water from its surface. Low relative humidity causes fruit burns, rapid red spider development, and even thrips. Even when the days grow shorter, the cucumber plant will continue to grow, flower and produce fruit normally (less than 12 hours of light). However, it has ability to tolerate a high intensity of light. The more sunlight gives abundant crop output. The presence of wind accelerates water loss and decreases relative humidity, increasing water demand. As a result of the lack of moisture in floral styles, fertilization is reduced, the plant's growth is slowed, production is reduced, and plant senescence is accelerated. (Anonymous, Agriculture.Agroinfo.com Cucumber growing Part I).

Cucumbers can be grown in a variety of loose soils because they're well-drained and have enough organic matter. The ideal pH for crop growth is between 5.5 and 7. The ideal soil temperature is from 18 to 20 °C with a minimum of 12 to 14 °C (Anonymous, Agriculture.Agroinfo.com).

A slight change in the physical structure or chemical substance of plant leaves would result in changes in their spectral characteristics and therefore, the spectral data end-products have the potential to reflect stresses imposed on crops. The use of spectral signature data using spectroradiometer is fast, non-destructive, and precise in monitoring changes of crops. Herbivore insects feed on crops that alter the leaf area, color, tissue structure, or content of chemical substances, so the feeding damages may be identified by spectral traits of crops. Spectroradiometer has a good prospect in monitoring insect pests on crops. Many studies have found that there are constant relationships between spectral index from crops and pest damage levels. The spectral reflectance of tobacco, especially in the infrared waveband ranges, decreased when tobacco leaves were suffered from aphid feeding (Qiao *et al.*, 2007) [7]. Ratio vegetation index (RVI) and normalized difference vegetation index (NDVI) that derived from spectral reflectance from crops were strongly related to the population size of insect pests on crops (Mirik *et al*., 2007) [6]. The sensitivity of a spectral index to crop stress determines its application prospect.

Material and Methods

The experimental field was conducted at the Department of Agricultural Entomology, College of Agriculture Parbhani, Vasantrao Naik Marathwada Krishi Vidhyapeeth, and Parbhani during the summer season 2020-21.

Experimental details

Season: Summer 2020-21
Design: Randomized Block Design
Treatment: Eight (8)
Replications: Three (3)
Crop: Cucumber
Variety: Gipsy
Spacing: 1.2m x 0.3m
Plot size: 3m x 2m
Number of plots: 24
Fertilizer Dose: 100:50:50 NPK kg/ha
Date of sowing: 19 January 2021

Table 1: Treatment details

Treat. No.	Treatment details	Insecticide(gm/ml)	Trade name	Company
T_1	Emamectin benzoate 5% SG	4ml	Proclaim	Syngenta
T_2	Flubendiamide 4800%SC	2.5ml	Fame	Bayer
T_3	Spinosad 45%SC	3ml	Tracer	Dow
T_4	Cyantranilioprole 10%EC	8ml	Benevia	EMC
T_5	Novaluron 10%EC	7.5ml	Rim-on	Indofil
T_6	Lambda cyhalothrin 5% SC	8ml	Karate	Syngenta
T_7	Chlorantraniliprole 18.5%SC	3ml	Coragen	EMC
T_8	Untreated control	-	-	-

Weather data including wind speed, temperature, humidity, heat index, thermal heat index, dew point, wet bulb, pressure and altitude were simultaneously measured on a weekly basis in the planting season. Data were analyzed to a relationship between yield and different insect pests and weather elements considered using statistical method. The daily meteorological data was collected from the Agril. Department of meteorology, VNMKV Parbhani.

The daily observation on air temperature, relative humidity, precipitation and bright sunshine hours were recorded at meteorological observatory. Some instruments were used to record weather indices they are mentioned below:

A) Spectroradiometer observation

The name of the spectroradiometer model is WAVE GO-VIS-50. Spectrometers measure relative spectral radiation over a specified wavelength range. Spectroradiometer is a light measurement tool that is able to measure both the wavelength and amplitude of the light emitted from a light source. Leaf spectrometers are used to detect and quantify the amount of chlorophyll in leaves with the help of several formulas.

I. Normalized Difference Vegetation Index (NDVI)

Calculation of the Normalized Difference Vegetation Index (NDVI), which is available on the-fly, comes first. In addition, NDVI is often used around the world to monitor

drought, forecast agricultural production, and assist in forecasting fire zones and desert offensive maps.
NDVI is calculated in accordance with the formula:

NDVI = (NIR-RED / NIR+RED)

Where,
NIR – reflection in the near-infrared spectrum
RED – reflection in the red range of the spectrum
This index defines values from -1.0 to 1.0, basically representing greens, where negative values are mainly formed from clouds, water and snow, and values close to zero are primarily formed from rocks and bare soil.

II. Enhanced Vegetation Index (EVI)
The enhanced vegetation index (EVI) has earned a huge attention for monitoring the vegetation quality and quantity like Normalized Difference Vegetation Index (NDVI). The primary use of EVI is to correct NDVI results simultaneously for atmospheric changes as well as soil background signals mainly in dense canopy zones. The EVI can be determined in the form of following equations:

EVI = (NIR-RED) (NIR+C1*RED-C2*BLUE+L)

Where,
NIR/red/blue represents the automatically corrected surface reflectance, L refers to the canopy background adjustment which defines non-linear, differential NIR and red radiant transfer through a canopy and C1, C2 are the coefficients of the aerosol resistance term.

III. Ratio Vegetation Index (RVI)
Jordan proposed in 1969 [3] one of the first VIs named Ratio Vegetation Index (RVI), which is based on the principle that leaves absorb relatively more red than infrared light; RVI can be expressed mathematically as:

$$\mathrm{RVI} = \frac{\mathrm{R}}{\mathrm{NIR}}$$

Where,
NIR - near infrared band reflectance
R - red band reflectance.
The RVI is widely used for green biomass estimations and monitoring, specifically, at high density vegetation coverage, since this index is very sensitive to vegetation and has a good correlation with plant biomass.

IV. Difference Vegetation Index (DVI)
The Difference Vegetation Index (DVI) was proposed by Jordan in (1969) [3] and can be expressed as

DVI = NIR – R.

The DVI is very sensitive to changes in soil background; it can be applied to monitoring the vegetation ecological environment. Thus, DVI is also called Environmental Vegetation Index (EVI).

V. Soil Adjusted Vegetation Index (SAVI)
Huete established the Soil Adjusted Vegetation Index (SAVI), which can be expressed as follow:

$$\mathrm{SAVI} = \frac{(\mathrm{Pn} - \mathrm{Pr})\,(1 + \mathrm{L})}{2a\,(\mathrm{Pn} + \mathrm{Pr} + \mathrm{L})}$$

The above model of a soil vegetation system was established to improve the sensitivity of NDVI to soil backgrounds where, L is the soil conditioning index, which improves the sensitivity of NDVI to soil background.

B) Soil Thermometer observation
Soil temperature data were recorded with mercury soil thermometer installed at 5, 15, 30 cm soil depths. Soil Thermometer data were recorded daily at two fixed times, first was in the morning at 0723 IST and second one in the afternoon at 0223 IST. Soil temperature data were taken up to 30 cm depth because temperature changes primarily occurred within that depth of soil in a temporal and spatial scale, while beyond 40-60 cm soil depth the change in soil temperature becomes non-significant (Scheffer *et al*., 2002) [11].

C) Green-seeker (NDVI)
The purpose of this study was to evaluate the reliability of the normalized of difference vegetation index (NDVI) calculated by the green seeker handheld sensor as an indirect indicator of the nitrogen status of tomato and cucumber growing in greenhouse.
NDVI is calculated in accordance with the Formulae:

NDVI = (NIR-RED / NIR+RED)

Where,
NIR – reflection in the near-infrared spectrum
RED – reflection in the red range of the spectrum

G) Pocket Weather Meter
The name of the Pocket weather meter model is Kestrel by which the following observations are recorded. Wind Speed, Temperature, Heat Stress Index, Dew-point temperature.

Result and discussion:
1) Days require to first flower
The data on the days require to first flower is shown in Table 2. It was found that, treatment T_4 *i.e*. (spraying of Cyantraniliprole 10% SC) requires minimum days for first flower (35 days) which gives higher NDVI values as compared to rest in treatments because of higher NDVI values the photosynthetic rate of plant was more and makes the plant healthy and healthy plant gives a greater number of fruits during its entire growth period in T_4.
Growth rate of the crop depends on the average 24 hrs. temperature the higher the average air temperature the faster the growth. The larger the variation in day night air temperature, the taller the plant and the smaller the leaf size. Although maximum growth occurs at a day and night temperature of about 28 °C, maximum fruit production is achieved with a night temperature of 19 to 20 °C and a day temperature of 20 to 22 °C reported by Kumar *et al.*, (2020).

2) Days require to first fruit
The data on the days require to first fruit shown in Table 2. It was found that, treatment T_4 *i.e.* (spraying of Cyantraniliprole 10% SC) requires minimum days for first fruiting (49 days) which gives higher NDVI values as compared to rest in treatments because of higher NDVI values the photosynthetic

rate of plant was more and makes the plant healthy and healthy plant gives a greater number of fruits during its entire growth period in T_4. It was at par with treatment T_7 (49.3), T_1 (50.0) and T_3 (50.1).

Growth rate of the crop depends on the average 24 hr. temperature the higher the average air temperature the faster the growth. The larger the variation in day night air temperature, the taller the plant and the smaller the leaf size. Although maximum growth occurs at a day and night temperature of about 28 °C, maximum fruit production is achieved with a night temperature of 19 to 20 °C and a day temperature of 20 to 22 °C reported by Kumar *et al.,* (2020).

3) Days require to first harvest

The data on the days require to first harvest presented in Table 2. It was found that, treatment T_4 *i.e.* (Cyantraniliprole) requires minimum days for first harvesting (56 days) which gives higher NDVI values as compared to rest of the treatments and less effect of insect pest during its entire growth period in T_4.

From the above observations it can be concluded that application of Cyantraniliprole 10% SC gave best results in terms of growth and development was better and minimum days require to first harvest, the similar findings were reported by Kumar *et al.,* (2020).

Table 2: Influence of various treatments on days require to first flower, first fruit and first harvest during 2020-2021.

Treatment number		Days require to 1st flower	Days require to 1st fruit	Days require to 1st harvest
T_1:	Emamectin benzoate 5% SG	37	50	59
T_2:	Flubendamide 480% SC	38	49	59
T_3:	Spinosad 45% SC	37	50	59
T_4:	Cyantraniliprole 10% SC	35	49	56
T_5:	Novaluron 10% EC	38	51	60
T_6:	Lambda cyhalothrin 5% SC	36	52	61
T_7:	Chlorantraniliprole 18.5% SC	39	49	58
T_8:	Untreated control	40	52	58
SE(m)		1.01	0.63	0.65
C.D.		NS	1.92	1.99

Yield per plot (kg)

The data on the yield per plot presented in Table 3. Present data indicated that, influences of weather parameter were significantly affected with respect to the yield per plot. The maximum number of yields per plot (kg) was found in T_4 treatments i.e., Cyantraniliprole 10% SC (26.0).

Fruit development appeared to be closely related to the temperature sum. When the growth of a fruit was not constrained by assimilate supply, a decrease in growing period with increasing temperature was more than compensated for by a strong increase in growth rate, resulting in an increase in final fruit weight. However, when assimilate supply did constrain fruit growth the number of cells per fruit decreased with increasing temperature, while the effect on cell size was negligible (Marcelis & Hofman-Eijer, 1993) [5].

Yield per hectare (kg)

The data shows that, influence of weather parameter was significantly affected with respect to the yield per hectare in (Table 3).

It was observed that, in T_4 treatment, the yield per hectare (kg) was (42,472.3 Kg/ha) weighing more due to number of fruits per plant and weight of fruit per plant was more with healthy vegetation i.e., high values of (NDVI, EVI, RVI and DVI) and timely fruiting, and maturity of plant and less pest infestation of this treatments.

This is due to more vegetation growth, leaf area index, number of nodes and diffused light at the time of flowering and fruit development. Higher number of fruits per plant and fruit weight also contributes to more yield per plant. More number of fruits per plant and fruit yield per plant ultimately contributed to more fruit yield per hectare in cucumber. Similar findings were also reported by Anjanappa *et al*., (2012) [1], Pant *et al*. (2001) [10] and Lawlor (1995) [4].

Table 3: Influence of various treatments on yield/plot and yield kg/ha of cucumber during 2020-2021.

Treatment Number		Yield /plot	Yield kg/ha
T_1:	Emamectin benzoate 5% SG	20.0	34,205.7
T_2:	Flubendamide 480% SC	23.2	38,583.0
T_3:	Spinosad 45% SC	24.5	40,766.3
T_4:	Cyantraniliprole 10% SC	26.0	42,472.3
T_5:	Novaluron 10% EC	21.3	35,572.0
T_6:	Lambdacyhalothrin 5% SC	21.0	34,877.7
T_7:	Chlorantraniliprole 18.5% SC	21.0	34,794.3
T_8:	Untreated control	19.0	31605.7
SE(m)		2.49	4.29
C.D.		NS	NS
G. Mean		22.0	36,609.6

Conclusion

The overall assessment of the result of present investigation on the "Influence of weather parameters on growth and yield of cucumber" concluded that use of treatment T_4 (Cyantraniliprole 10% SC) was found superior to minimum days required for 1st flower, days required for 1st fruit, days required for 1st harvest as well as maximum number of fruits per plant, weight of fruit per plant, yield of fruit per plot and yield of fruit kg/ha was recorded. Treatment T_4 (Cyantraniliprole 10% SC) was found as a best for increasing growth, yield, and spectral indices like EVI, DVI, RVI, SAVI & NDVI of cucumber.

Hence for study the "Influence of weather parameters on growth and yield of cucumber" It is evident that the use of T_4 (Cyantraniliprole 10% SC) as a best for increasing growth, yield and spectral indices like EVI of cucumber.

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