hence higher plume height. During pre-monsoon, relative humidity is comparatively much lower and ranges from 45% to 60% within first kilometer of the boundary layer. Though temperature gradient of 11°C/km is maximum during pre-monsoon season but nearly dry air conditions prevailing at all levels require high threshold lapse rate for air instability to occur, leading to shallow convective boundary layer and lower plume heights. Similar explanation holds good for other two seasons viz., winter and post-monsoon but lower plume height during winter may partly be attributed to short duration of sunshine. Thus the results of present study clearly show the predominance of relative humidity in controlling the height of plumes and hence the depth of convective boundary layer.

3. Conclusion - Seasonal variations in the onset and dissipation times show that effective period for dispersal of pollutants is minimum (4 hours) in winter and maximum (8 hours) during pre-monsoon period. Plumes’ average height shows diurnal variation and is maximum around 1300 hrs irrespective of the season. An important aspect of the present study is the contribution of humidity on the plume height. High humidity leading to higher plume heights suggests that places with high water content are most suitable for setting up the industries to minimize air pollution.
TABLE 1
Crop yield and distribution of agroclimatic factor

<table>
<thead>
<tr>
<th>Year</th>
<th>Duration in weeks</th>
<th>Frequency of irrigation</th>
<th>Rainfall (mm)</th>
<th>Departure from normal rainfall (mm)</th>
<th>AET (mm)</th>
<th>Yield (kg/ha)</th>
<th>W.U.E (kg/ha-mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989 - 90</td>
<td>19</td>
<td>5</td>
<td>89.4</td>
<td>39.4</td>
<td>348</td>
<td>2900</td>
<td>8.3</td>
</tr>
<tr>
<td>1990 - 91</td>
<td>20</td>
<td>5</td>
<td>47.6</td>
<td>2.4</td>
<td>362</td>
<td>3360</td>
<td>9.3</td>
</tr>
<tr>
<td>1992 - 93</td>
<td>16</td>
<td>4</td>
<td>31.4</td>
<td>18.6</td>
<td>318</td>
<td>2168</td>
<td>6.8</td>
</tr>
<tr>
<td>1993 - 94</td>
<td>18</td>
<td>4</td>
<td>67.2</td>
<td>17.2</td>
<td>336</td>
<td>2560</td>
<td>7.6</td>
</tr>
<tr>
<td>1994 - 95</td>
<td>16</td>
<td>4</td>
<td>53.2</td>
<td>3.2</td>
<td>322</td>
<td>2450</td>
<td>7.6</td>
</tr>
<tr>
<td>1995 - 96</td>
<td>18</td>
<td>4</td>
<td>88.8</td>
<td>38.8</td>
<td>338</td>
<td>2955</td>
<td>8.7</td>
</tr>
<tr>
<td>1996 - 97</td>
<td>20</td>
<td>5</td>
<td>27.0</td>
<td>23.0</td>
<td>356</td>
<td>3050</td>
<td>8.6</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>-</td>
<td>57.8</td>
<td>-</td>
<td>340</td>
<td>2778</td>
<td>8.1</td>
</tr>
</tbody>
</table>

point (PWP) of 5.5% and bulk density of 1.5 g/cc. The crop was sown during second fortnight in December and harvested in April. The growth duration of the crop varied between 16 to 20 weeks. The actual evapotranspiration (AET) was measured with gravimetric Lysimeter (1.3 × 1.3 × 0.9 m) fixed within the crop field, whereas data on meteorological parameters (maximum and minimum temperature, relative humidity, sunshine hours and wind speed etc.) recorded at the observatory located near the experimental farm, was obtained from India Meteorological Department, Pune. The weekly potential evapo-transpiration (PET) was calculated using Penmann’s modified formulae (Doorenboss and Pruitt, 1977). The crop coefficient \( (K_c) \) was calculated by using the following relationship:

\[
K_c = \frac{ET}{PET} \tag{1}
\]

The irrigation interval \( (I) \) in days, has been calculated using the relationship:

\[
I = \frac{S_a \times p \times d}{ET} \tag{2}
\]

Where, \( S_a \) = available soil water (mm/m), \( p \) = fraction of available water, \( d \) = effective root zone depth for irrigation, \( ET \) = peak value of evapotranspiration (mm/day). In the study, \( p = 0.50 \) has been assumed and the effective root zone depth for irrigation, \( d = 90 \) cm has been used (Michael, 1990).

2. Consumptive use of water (AET), water use efficiency (WUE) and crop coefficient \( (K_c) \) - The AET varied between 318 mm to 362 mm (Table 1). On an average the crop needs about 340 mm of water during the growth cycle. Since, Varanasi receives only about 50 mm of normal rainfall during the season (IMD 1999), rest of the water must come from supplementary irrigation. The crop yield varied from a low yield value of 2168 kg/ha during 1992-93 to high yield of 3360 kg/ha during 1990-91. The average yield of the crop was 2778 kg/ha. The lowest value of 6.8 kg/ha-mm was observed in 1992-93, while highest value of 9.3 kg/ha-mm was observed in the year 1996-97 (Table 1). It clearly indicates that water use efficiency does not depend only on the total amount of water consumed by the crop but also on its distribution during the various growth stages of the crop.

As wheat crop is sensitive to water stress, it should be irrigated regularly by maintaining high moisture level in the root zone, above 50% of the available soil water.
with proper scheduling of irrigation in order to achieve good growth, development and yield. For this purpose, the irrigation interval \((I)\) was calculated using equation (2). It was found that wheat crop needs to be irrigated regularly at an interval not exceeding 21 days. Any further delay in irrigation may adversely affect the growth, development and yield of the crop.

Fig. 1. shows variation in crop coefficient \((K_c)\) with time, in weeks after sowing \((WAS)\), during the growth of wheat. The values of crop coefficient \((K_c)\) for wheat during different growth stages were compared with those given by Doorenboss and Kasam (1979) and agreed fairly well. When \(K_c\) values were fitted to time, in weeks after sowing \((WAS)\), the following non-linear relationship \((r = 0.92)\) was obtained,

\[
K_c = -0.1405 + 0.2136 \times (WAS) - 0.0097 \times (WAS)^2
\]

Using this equation, it is possible to estimate \(K_c\) values, any time in WAS, during different stages of crop growth.

3. (i) The AET in wheat crop was found to have varied between the range 318 mm to 362 mm. On an average, wheat crop consumed about 340 mm of water during the growth cycle.

(ii) Water use efficiency does not depend only on the total amount of water consumed by the crop.

(iii) It is suggested from these studies, in order that wheat crop does not suffer from water stress, the crop needs to be irrigated adequately, at an interval not exceeding 21 days.

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References


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