Moisture Analysis on Precipitation Days During vitis vinifera Growth in Hamedan Province Vineyards

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ABSTRACT: About 140 thousand tons of raisins are produced in Iran. Hamedan Province is one of the main areas of the country where produces grapes and raisins. Heavy rainfall events are one of the most climatic factors that impact on vitis vinifera during the phonology events. In this study, Moisture flux convergence was analyzed in heavy precipitation events in Hamedan Province. For this aim, daily precipitations of synoptic stations in this Province were used during March to October and from 1993 to 2008. Special humidity, Uwind and Vwind data are extracted from www.ncdc.noaa.gov site for 100 days in 500hpa, 600hpa, 700hpa, 850hpa, 925hpa and 1000hpa levels, at 00:00, 06:00, 12:00 and 18:00 times. MFC maps were computed by difference between advection function and convergence function. Frequency of MFC maps were calculated (MFC>4) at different levels and times. The humidity sources were traced for each heavy precipitation in different levels and times. The results show that there is the most frequency of MFC in 06:00 time from 850 to 1000 hpa and at 00:00 time from 500hpa to 700hpa. The results indicate that for 14% of cases, only one sea, for 21 % of cases, two seas, for 22 % of cases, three seas, for 38% of cases, four seas and for 5 % of cases, five seas contribute to prepare of humidity for heavy rainfall events in Haman province. The Mediterranean Sea and the Oman Sea in 850 hp to 1000 levels, and Mediterranean Sea and the Red Sea in the levels of 700 to 500 hpa are the most important supplier of humidity for heavy rainfall events in vineyards of Hamedan Province.

Keywords: MFC, Moisture sources, heavy precipitation, vitis vinifera, Hamedan

INTRODUCTION

Annual grapes production is about 68 million tons in the world that Iran produces about three million tons and is the eleventh producer and the third largest exporter of raisins after America and Turkey. About 850 thousand tons raisins are produced in the world that 140 thousand tons of them are provided by Iran. Grape production in Hamedan province is 350 thousand tons which are convert to the raisin about its 50%. Precipitation especially heavy rainfall is one of the most climatic factors during the growth of vitis vinifera which effect on quality and quantity of grapes. The humidity of the precipitations is prepared through Mediterranean Sea, Arabian Sea, Black Sea, Red Sea, Gulf of Oman, the Persian Gulf and the Caspian. The westerly winds transport moisture sources to Iran more than the other winds (Alijani, 2004). Studies show that Persian Gulf and the Indian Ocean have the highest and the lowest effect on monthly rainfall days in Yasooj respectively. Another study reveal that Mediterranean Sea, the Red sea and black Sea contribute to cause precipitation events in west of Iran, 45/4%, 37/7% and 16/9% respectively (Barati and Haider, 2006). In general, much researches have been carried out on precipitation and its humidity resources in Iran (Alijani, 1995; Hajari Zadeh, 2003; Khoshhal, 2009; Farajzadeh, 2009). They have shown that Arab and Mediterranean seas transfer the main source of moisture for rainfalls and
Red sea, Caspian Sea, Black Sea, Persian Gulf and Oman Sea are not very important. Most of the moisture is transferred to the lower levels of the atmosphere. The general pattern of wind flow and moisture transfer is highly dependent on atmospheric circulation patterns during the different years and it is influenced from high pressure zones in the lower levels of the troposphere. Accordingly, it can be East Arabian Peninsula high pressure, the North Africa high pressure and the Caspian Sea high pressure main transfers of moisture into the precipitation in Iran. On the other hand, there are a lot of researches about the Synoptic analysis of heavy precipitation in the word (Hend et al., 2004: 15; Lyvada et al., 2007: 43; Mohapatra and Mohanty, 2005: 17; Persson et al., 2005: 1175) and in Iran (Lashkari, 1996 and 2003; Alijani, 1995; Zolfaghari, 1998; Mofidi, 2004 and 2005; Mohammadi, 2009) that show the Low systems, fronts, troughs, influence the pool of cold air and strong convection and also the effect of sea surface temperature and ocean patterns are cause of heavy precipitation. The result of the pressure gradient between high pressure system in the North West of Iran and low pressure system in west or south of Iran cause heavy rainfall (Ghashghaie, 1996, Khoshhal, 1997; Hosynjany, 2004; Alijani, 2001; Moradi, 2004; Masoodian, 2008). Many studies have spoken from the effects of heavy rainfall on flowers, fruits, and various agricultural crops (Wang et al., 2011: 27; Sun et al., 2006: 4560; Banacos et al., 1970: 351; Montealegre et al., 2006: 687; Gladstones et al., 2004: 90; Cardoso et al., 2008: 441; Chavarria et al., 2009: 2029; Detoni et al., 2007: 530). The aim of this research is study of Moisture Flux Convergence in the heavy precipitation days in Hamedan province vineyards.

**Study Area**

The province of Hamedan covers an area of 19,546 km². The major cities of Hamedan province are: Hamedan, Toyserkhan, Nahavand, Malayer, Asad Abad, Bahar, Razan, Kabudrahang. The province lies in an elevated region, with the ‘Alvand’ mountains, running from the North West to the south west. These are part of the Zagros mountain range of Iran. Hamedan enjoys temperate warm summers and relatively cold winters. The vineyards of Hamedan province are mostly in Malayer, Hamedan and Nahavand. The production of grapes in Hamedan province is 350 thousands tones that half of it is transformed to raisins.

**MATERIALS AND METHODS**

For this aim, daily precipitations of Hamedan, Malayer and Nahavand synoptic stations were used from March to October and from 1993 to 2008. Special humidity, Uwind and Vwind data are extracted from www.ncdc.noaa.gov for 100 days in 500hpa, 600hpa, 700hpa, 850hpa, 925hpa and 1000hpa levels, at 00:00, 06:00, 12:00 and 18:00 times and in 2.5º*2.5º spatial resolution. MFC maps were computed by difference between advection function and convergence function. The moisture flux convergence equation is based on the principle of continuity of water vapor can be written as:

\[
\frac{dq}{dt} = S \tag{1}
\]

where

\[
\frac{d}{dt} = \frac{\partial}{\partial t} + u \frac{\partial}{\partial x} + v \frac{\partial}{\partial y} + \omega \frac{\partial}{\partial p},
\]

q, specific humidity
S, water vapor storage that is computed by the difference between the output and input of water vapor in air parcel.

\[
S = E - P \tag{2}
\]

\[
\frac{\partial q}{\partial t} + u \frac{\partial q}{\partial x} + v \frac{\partial q}{\partial p} + \omega \frac{\partial q}{\partial p} + q \left( \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial \omega}{\partial p} \right) = E - P \tag{3}
\]

\[
\text{MFC} = -\nabla \cdot (q \vec{V}_h) = -\vec{V}_h \cdot \nabla q - q \nabla \cdot \vec{V}_h, \tag{4}
\]
Then, frequency of MFC maps were calculated (MFC>4) in different levels and times from -20º W to 120º E and from 0º N to 80º N. The moisture flux convergence is the amount of moisture in the air that moves toward a point. It is the combination of moisture convergence and moisture advection. To determine the function of moisture flux convergence specific humidity and wind components are used as an important parameter to predict the thunderstorms and heavy rain falls.

RESULTS AND DISCUSSION

The maps of frequency of moisture flux convergence function for heavy precipitation events at the level of 1000 hp and also at 0:00(figure1), 06:00(figure2), 12:00(figure3) and 18:00(figure4) times showed that this level is effectiveness in providing the humidity for heavy rainfalls at vineyards in the province of Hamedan (more than 40%). The highest value at 06:00 (more than 70%) is observed. The frequency of moisture flux convergence for heavy precipitation events at the 925 hPa level during the hours of 00:00(figure5), 06:00(figure6), 12:00(figure7) and 18:00(figure8) showed that this level is an effective level to supply humidity (more than 30). The frequency of moisture flux convergence in episodes of heavy rainfall at the level of 850 hPa (figures 9, 10, 11 and 12) showed that the level is important for the provision of precipitation (more than 20 %). The highest value at 06:00 (about 50%) is observed. In this case, the value of the humidity core is more than 60 percent. The lowest values are visible at 00:00 and 18:00 hours. This function at the 700 hPa level (figures13, 14, 15 and 16) showed that this level is not much effective in providing moisture. At 06:00 and 00:00 hours, this frequency is more than 30 percent over the region. At 18:00 hour, the lowest value of the frequency is seen (20 percent). The maps (figures 17, 18, 19, 20, 21 and 22) showed that there is not sufficient humidity at the level of 600 and 500 hPa.
Figure 5. Frequency of MFC for heavy precipitation in 925 hpa at 00:00

Figure 6. Frequency of MFC for heavy precipitation in 925 hpa at 06:00

Figure 7. Frequency of MFC for heavy precipitation in 925 hpa at 12:00

Figure 8. Frequency of MFC for heavy precipitation in 925 hpa at 18:00

Figure 9. Frequency of MFC for heavy precipitation in 850 hpa at 00:00

Figure 10. Frequency of MFC for heavy precipitation in 850 hpa at 06:00

Figure 11. Frequency of MFC for heavy precipitation in 850 hpa at 12:00

Figure 12. Frequency of MFC for heavy precipitation in 850 hpa at 18:00
Figure 13. Frequency of MFC for heavy precipitation in 700 hpa at 00:00

Figure 14. Frequency of MFC for heavy precipitation in 700 hpa at 06:00

Figure 15. Frequency of MFC for heavy precipitation in 700 hpa at 12:00

Figure 16. Frequency of MFC for heavy precipitation in 700 hpa at 18:00

Figure 17. Frequency of MFC for heavy precipitation in 600 hpa at 00:00

Figure 18. Frequency of MFC for heavy precipitation in 600 hpa at 06:00

Figure 19. Frequency of MFC for heavy precipitation in 600 hpa at 12:00

Figure 20. Frequency of MFC for heavy precipitation in 600 hpa at 18:00
The results indicate that in 1000 to 850 hPa levels that are the most important levels to transfer moisture into the region for 14% of cases, only one Sea, for 21% of cases, two seas, for 22% of cases, three seas of 38% of cases, four seas and for 5% of cases, five seas are involved in moisture of heavy precipitation. Table 1 show the percentage contribution of the different Seas to generate heavy precipitation in Hamedan province vineyards.

| Table 1. The role of the Seas to generate heavy precipitation in Hamedan Province |
|-----------------------------------|-----------------|-----------------|
| Humidity                         | 850 to 1000 hPa levels | 500 to 700 hPa levels |
| Caspian Sea                      | 1%               | 0%              |
| Black Sea                        | 7%               | 3%              |
| Mediterranean Sea                | 66%              | 81%             |
| Persian Gulf                     | 17%              | 14%             |
| Oman Sea                         | 45%              | 5%              |
| Red Sea                          | 31%              | 43%             |
| Arabian Sea                      | 39%              | 25%             |

CONCLUSION

The results show that there is the most frequency of MFC in 06:00 time from 850 to 1000 hPa and in 00:00 time from 500hPa to 700hpa. The most frequency MFC is in 1000 hPa level (more than 90%). The most important levels of moisture transferred to the region are 1000 to 850 hPa. Generally the results indicate that for 14% of cases, only one sea, for 21% of cases, two seas, for 22% of cases, three seas, for 38% of cases, four seas and for 5% of cases, five seas contribute to prepare of humidity for heavy rainfall events in Haman province. The Mediterranean Sea and the Oman Sea in 850 hp to 1000 levels, and Mediterranean Sea and the Red Sea in the levels of 700 to 500 hpa are the most important supplier of humidity for heavy rainfall events in vineyards of Hamedan.

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