

Sorption Isotherm Phenomena in Cured Oriental Tobacco

I. Water Activity Behavior and Hysteresis

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ABSTRACT

Valuable information can be obtained from the examination of moisture content of tobacco leaves in relation to environmental conditions, especially during the time course of handling . Moisture sorption isotherms of locally grown tobaccos were examined . Tobacco leaves of cultivars behaved differently in term of water activity . Moisture sorption isotherms of midrib were higher than those of lamina . Temperature dependance of sorption isotherms were apparent . Hysteresis phenomena were distinct . Leaves were different in their hysteresis .

INTRODUCTION

Moisture sorption isotherms (MSI) which express the linkage between equilibrium moisture content (EMC) and water activity (a_w) are of great significance to industrial handling of tobacco (1,2,3 and 4) . MC regulates the damages which do occurs during handling and processing . Mathematical equation have been widely used to describe MSI phenomena in hygroscopic materials (5) . Several models applied in agricultural products were evaluated to describe an applicable and accurate model valuable for oriental tobacco (4,6) . Various of these equation were found to be appropriate for characterizing the relationship between MC and a_w . It has been proposed that the best model for both , adsorption and desorption was that of Henderson or modification of this (4,7) .

The behavior that the MC of capillary porous material being always little higher when the a_w is achieved by desorption in comparison to the MC when the same a_w is maintained by adsorption to a dry material , i.e. , hysteresis looping (8) . This phenomena had been reported to be apparent in tobaccos (4) . The examination of MSI will offer information concerning the exact relative humidity need to be retained during any handling operation . In order to describe the tobacco leaf responses in term of a_w , this study had been conducted to evaluate the MSI behavior for a wide range of locally grown tobacco cultivars in Kurdistan .

MATERIAL AND METHODS

Oriental tobacco leaves (*Nicotiana tabacum* L.) of two cultivars, Gollsur and Prelip were examined by stalk position, in addition, a uniform grope of grade A leaves (rated excellent) of locally grown tobaccos of Pishdar, Sharbazher, and Shaqlawa, with grade C of Chamchamal were studied also. Midrib was separated from lamina. Leaf lamina was separated into three pieces (tip, middle, and base in a manner being perpendicular to the leaf axis). Each piece being one third of the leaf in length. Thus, tobacco samples consisted of entire leaf lamina, leaf midrib (stems), leaf tip, leaf middle and leaf base by stalk position for Gollsur and Prelip cultivars. Because of the fact that most of the tobacco grown locally are a mixture of all priming (3,6), tobacco samples of Pishdar, Sharbazher, Shaqlawa and Chamchamal were taken randomly from the tonga as a mixture. Thus uniform leaves in visible criteria, such as color, size, shape, thickness, elasticity and texture were chosen which represent the upper stalk position. Samples prepared for analysis and examined for adsorption and desorption properties as mentioned elsewhere (4). All testes were conducted in six replicates.

RESULTS AND DISCUSSION

MSI were examined using the empirical formula of Henderson (7), due to a high r^2 , as it has been shown (4). In addition, it can be applied in a wide range of a_w . Henderson model is described as,

$$1 - p/p_0 = e^{-KTX^n}$$

where, $p/p_0 = a_w$ (9); T = temperature, °K; X = MC, % dry basis; K and n = constant parameters. Hysteresis looping (HL) was calculated as a difference in MC between desorption and adsorption. Hysteresis values were obtained by integration of the area under the curve and reported in the text in term of unit area (UA). MSI for all the samples examined were conducted over a range of $0.15 \leq a_w \leq 0.82$, thus, under a wide range of relative humidity (RH).

Leaf tip of 2nd priming of Prelip was found to hold more moisture compared to Gollsur (Fig.1). Hysteresis was apparent in both, it extended all over the moisture range tested. Middle and base portion of the leaf showed the same pattern as the tip (Fig.2&3). The leaf base of both cultivars hold more moisture in the range of $0.75 \leq a_w \leq 0.82$. Hysteresis was decreased sharply in all the three leaf portions of Gollsur, near the range of $0.58 \leq a_w \leq 0.72$, in comparison with the smooth decline of

hysteresis in Prelip . Hysteresis was greater in the tip and middle portion of the Prelip leaves than in Gollsur . while in leaf base was opposite . In term of thermodynamic concept , the state of the constituent water is temperature dependent , that is , sorptive capacity decreases as temperature increases (5,10) . This behavior is pronounced in (Fig.4) if it is compared with (Fig.1,2&3) . The values were lower at 32°C for the 2nd priming of both cultivars in comparison with the values at 21°C , hysteresis was less , however , diffusion was found to be positively correlated with drying temperature during the drying of oriental tobacco (11) . Hysteresis increased as a_w increased for the leaf of 2nd priming of Gollsur , the opposite was true for the leaf of Prelip (Fig.4) .

Temperature dependence of isotherms can be seen more clearly in (Fig.5&6) . At 21°C , the EMC of the midrib of 2nd priming of both cultivars was higher than at 32°C over all a_w region . Hysteresis was also greater at 21°C . The midrib of Prelip had higher MC than Gollsur at the region of $a_w \geq 0.58$ and higher , at both 21 & 32°C . MSI of midrib over any a_w range and at any temperature were found to be higher than lamina . Further , midrib possess greater hysteresis . Leaves of 2nd and 4th priming of Gollsur had similar isotherms at 32°C (Fig.4&7) . For both cultivars , hysteresis was greater in 4th than 2nd priming . MSI of midrib of 4th priming was higher than of the lamina in both cultivars , especially in the region of $a_w \geq 0.50$ (Fig.7&8) . At 32°C , similar behaviors were found in MSI of the midrib of 2nd and 4th priming of both cultivars (Fig.6&8) .

At 21°C , leaf lamina of Pishdar and Sharbazher tobacco had similar pattern in their MSI (Fig.9) . They behaved similarly to Prelip . Leaves of Sharbazher showed to possess much greater MSI than Pishdar and Shaqlawa tobacco . But even with higher MC , hysteresis in Shaqlawa leaves was similar in pattern to that of Gollsur at 32°C , in which hysteresis increase as a_w increased . The lamina of the local tobaccos of Pishdar and Chamchamal , tested at 32°C showed lower MSI values (Fig.10) in comparison with those tested at 21°C . Pishdar tobacco had higher MSI values at $a_w \geq 0.35$. The midribs of both tobaccos possess higher MSI and greater hysteresis than their lamina (Fig.10&11) .

The values of the constant parameters n and k for the tobaccos examined are shown in table I and II , at 21 and 32°C respectively . As reported previously (4) , the values of the n constant increases as the values of k decreases for all the tobaccos tested . Value of n were found to be higher at 32°C than at 21°C for the same tobacco . Thus , k values appear to behave in opposite manner . Values of n for desorption were higher than for adsorption at both 21 & 32°C . K values for desorption were smaller than for adsorption (Table I&II) . Generally , n values for lamina were

higher than of midrib . The values of n and k constants are more descriptive of the thermodynamic relationships involved in adsorption and desorption process in tobacco . They represent the nature of surface of exchanger and characteristics of the system . However , low n values are associated with high MSI for most of the samples tested .

ACKNOWLEDGMENT

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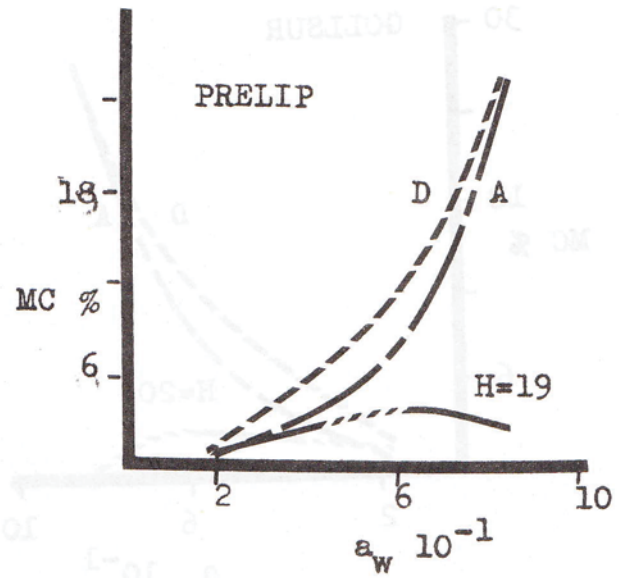
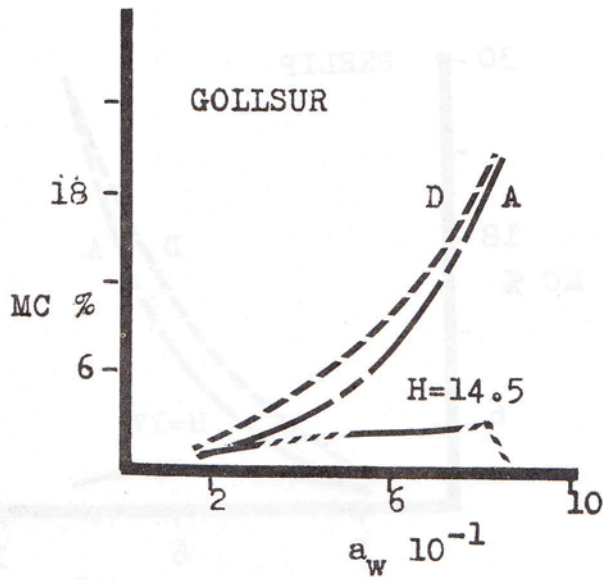


Fig. 1: MSI of leaf lamina tip, 2nd priming at 21°C .

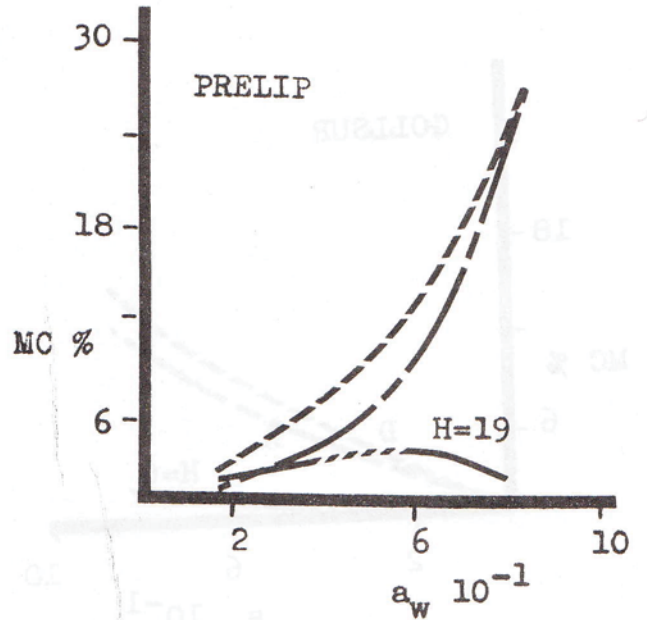
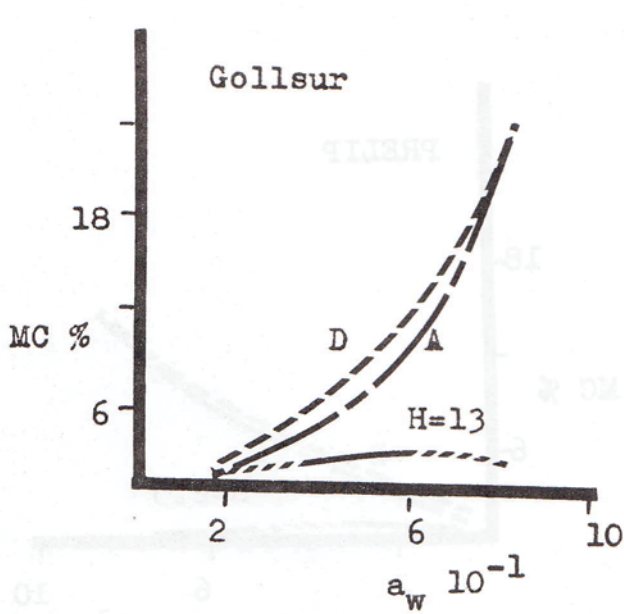


Fig 2: MSI of leaf lamina middle, 2nd priming at 21°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

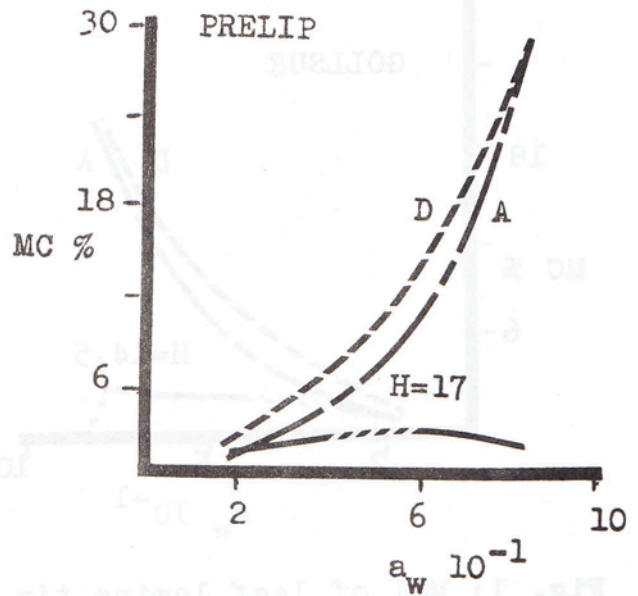
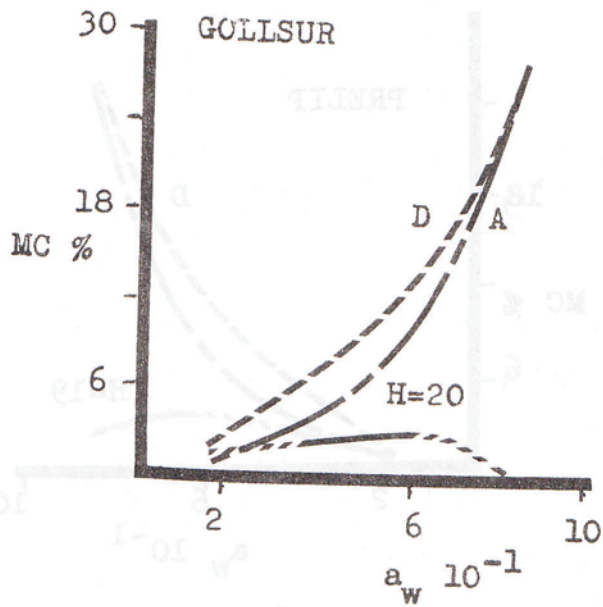


Fig. 3: MSI of leaf lamina base, 2nd priming at 21°C.

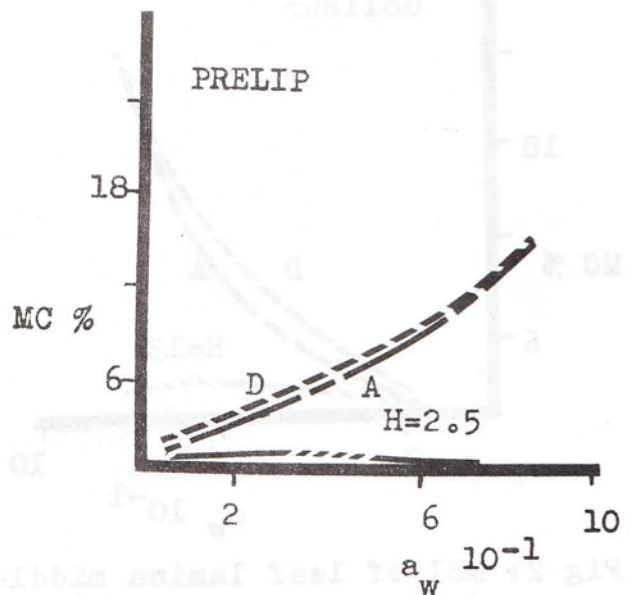
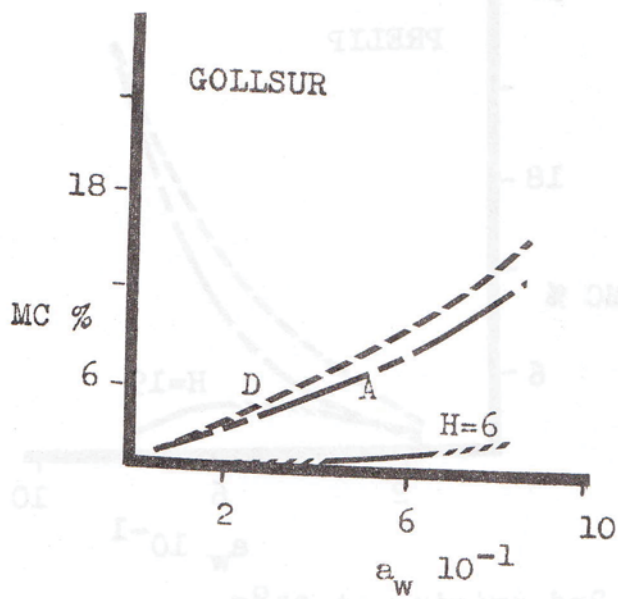


Fig. 4: MSI of entire leaf, 2nd priming at 32°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

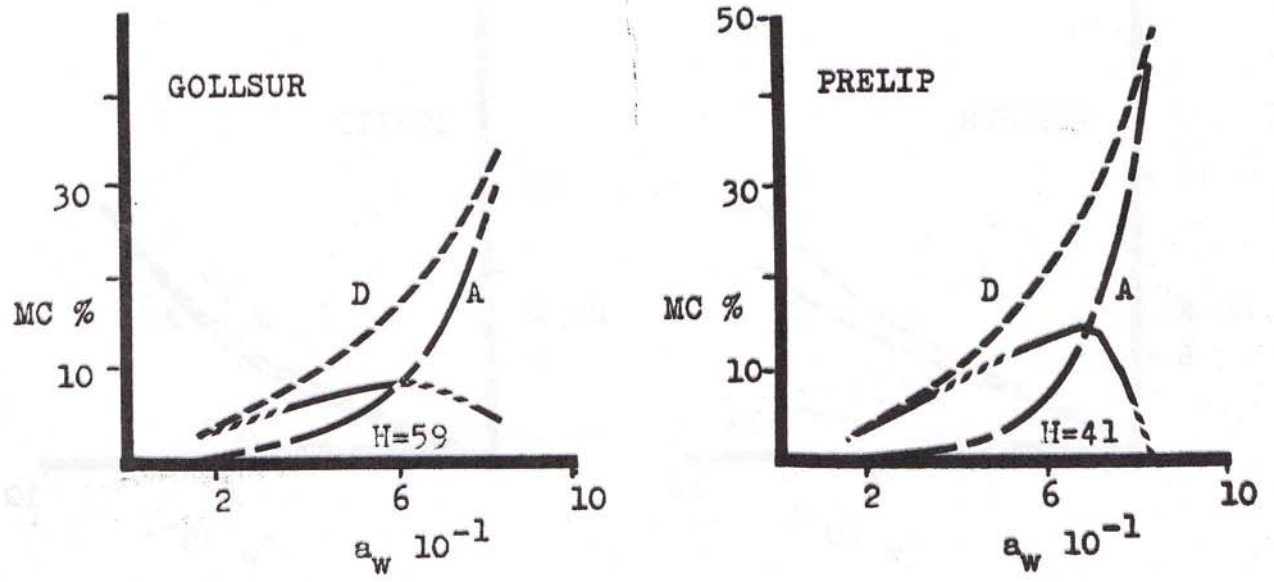


Fig. 5: MSI of leaf midrib, 2nd priming at 21°C.

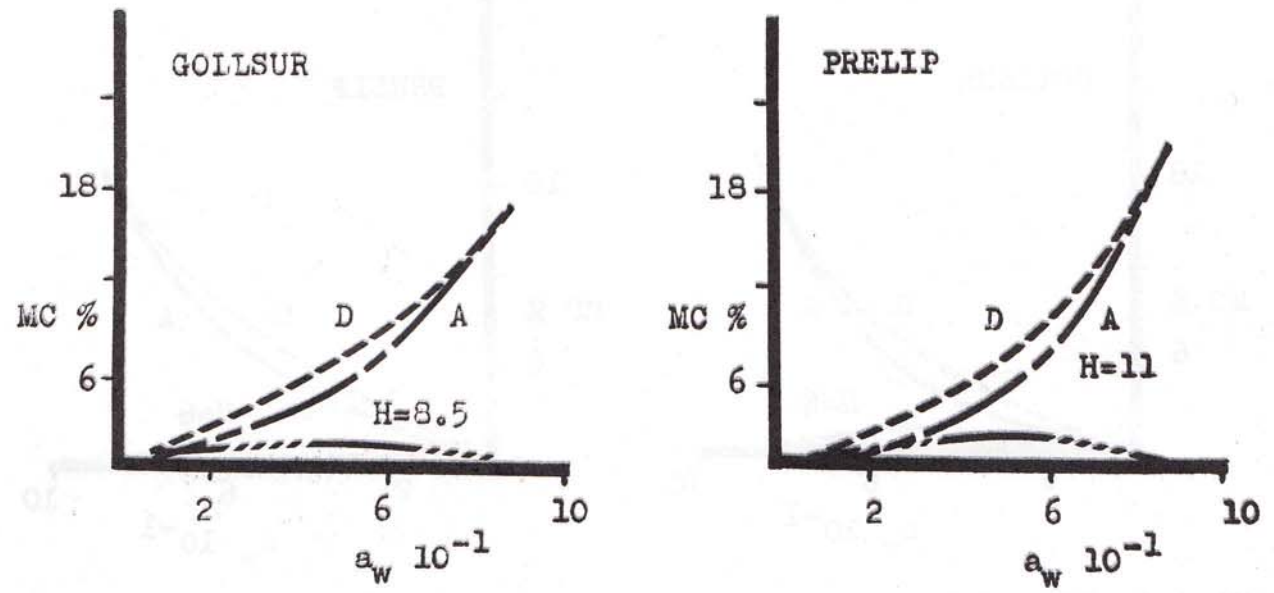


Fig. 6: MSI of leaf midrib, 2nd priming at 32°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

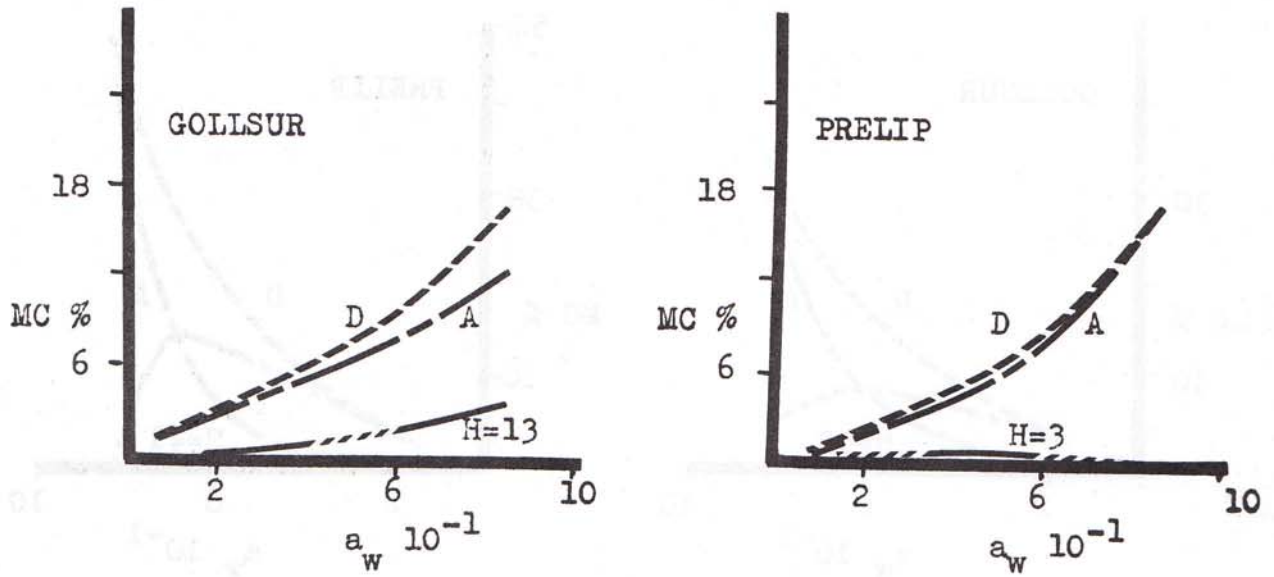


Fig. 7: MSI of entire leaf lamina, 4th priming at 32°C.

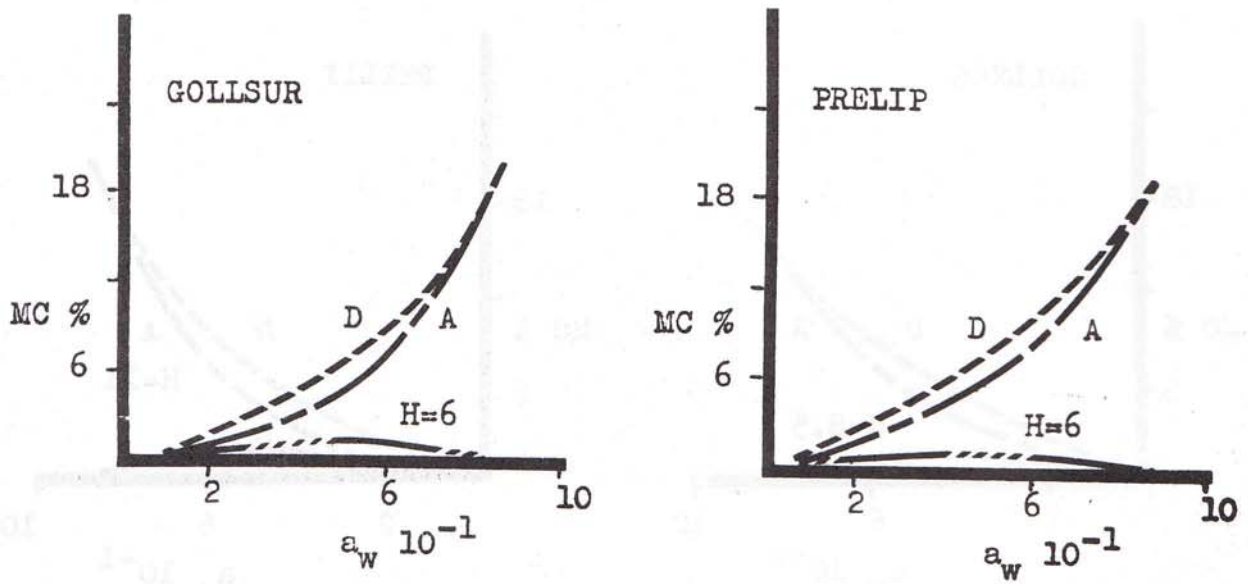


Fig. 8: MSI of leaf midrib, 4th priming at 32°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

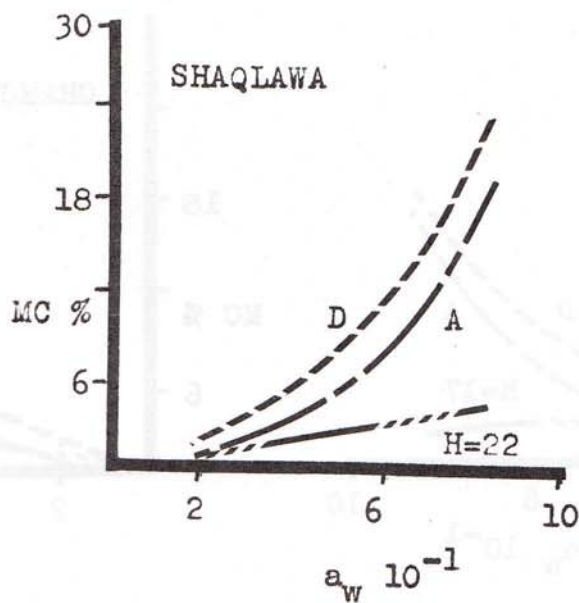
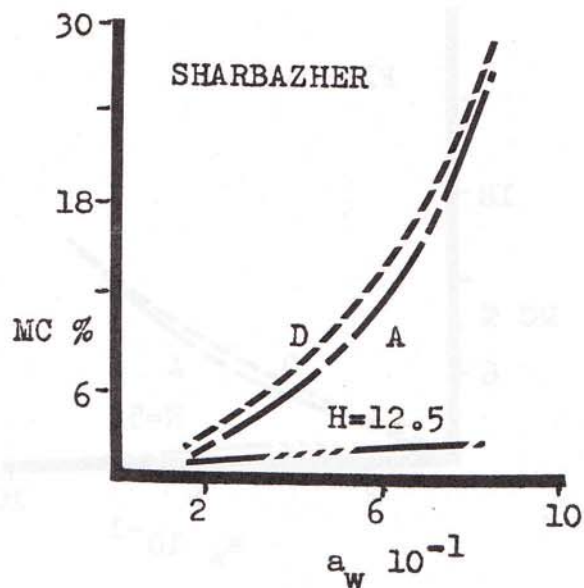
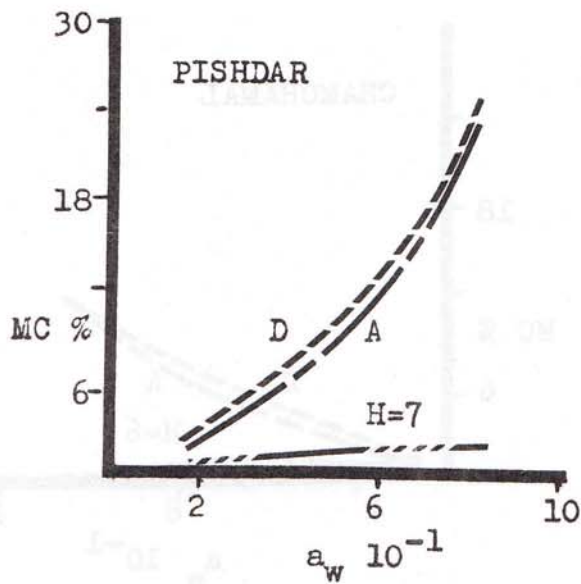


Fig. 9: MSI of leaf lamina of local tobacco at 21°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

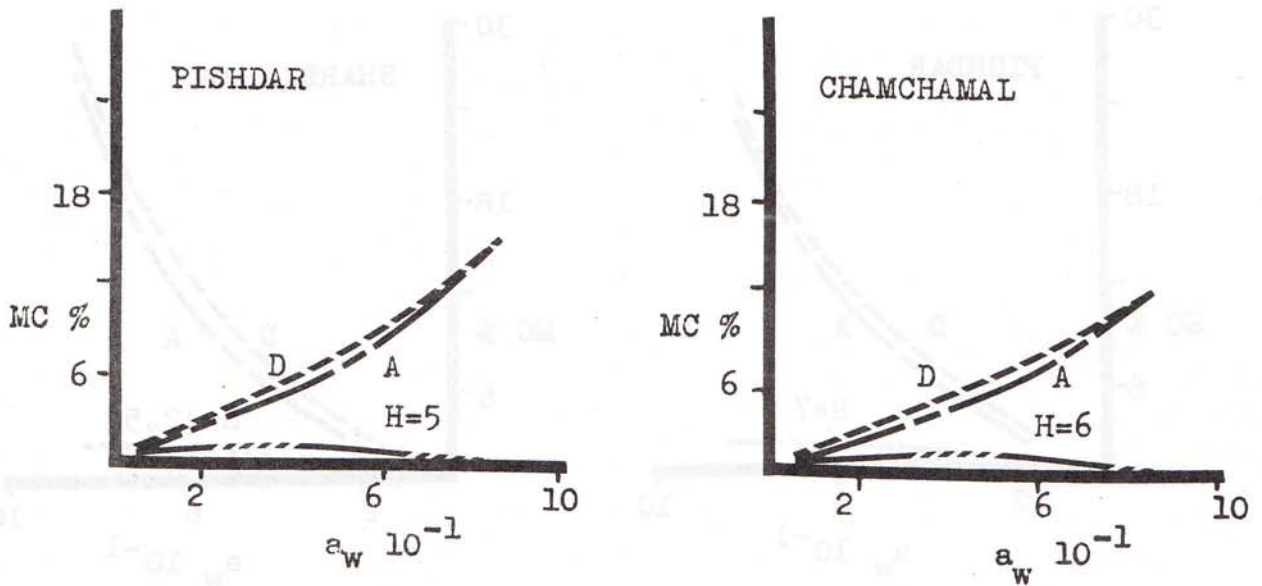


Fig. 10: MSI of leaf lamina of local tobacco at 32°C.

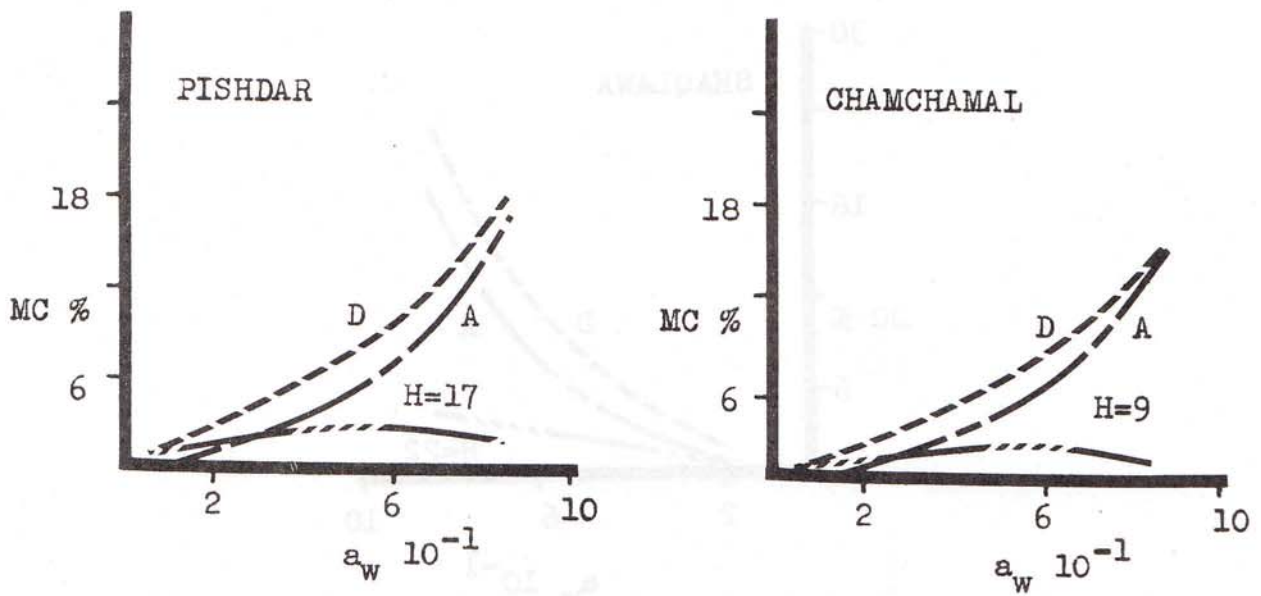


Fig. 11: MSI of leaf midrib of local tobacco at 32°C.
 A=ADSORPTION; D=DESORPTION; H=HYSTERESIS in unit area.

**Table I : Calculated values of constant n and k for
the tobacco investigated at 21°C**

TOBACCOS	ADSORPTION		DESORPTION	
	n	k	n	k
Gollsur 2nd I	0.647	8.244 X 10 ⁻⁴	0.827	4.544 X 10 ⁻⁴
Gollsur 2nd II	0.699	6.505 X 10 ⁻⁴	0.841	3.855 X 10 ⁻⁴
Gollsur 2nd III	0.631	7.105 X 10 ⁻⁴	0.896	3.024 X 10 ⁻⁴
Gollsur midrib	0.459	1.192 X 10 ⁻³	0.902	2.375 X 10 ⁻⁴
Prelip 2nd I	0.566	9.233 X 10 ⁻⁴	0.763	4.625 X 10 ⁻⁴
Prelip 2nd II	0.620	7.406 X 10 ⁻⁴	0.878	3.100 X 10 ⁻⁴
Prelip 2nd III	0.640	6.912 X 10 ⁻⁴	0.817	3.668 X 10 ⁻⁴
Prelip midrib	0.342	1.549 X 10 ⁻³	0.785	2.774 X 10 ⁻⁴
Pishdar	0.887	3.523 X 10 ⁻⁴	0.969	2.524 X 10 ⁻⁴
Sharbazher	0.778	4.412 X 10 ⁻⁴	0.862	3.133 X 10 ⁻⁴
Shaqlawa	0.747	4.349 X 10 ⁻⁴	1.034	2.378 X 10 ⁻⁴

I = Leaf tip ; II = Leaf middle ; III = Leaf base ; 2nd = Second priming

**Table II : Calculated values of constant n and k for
the tobacco investigated at 32°C**

TOBACCOS	ADSORPTION		DESORPTION	
	n	k	n	k
Gollsur 2nd	1.441	1.632 X 10 ⁻⁴	1.399	1.334 X 10 ⁻⁴
Gollsur 2nd midrib	0.813	5.943 X 10 ⁻⁴	1.101	2.764 X 10 ⁻⁴
Gollsur 4th	1.449	1.547 X 10 ⁻⁴	1.309	1.553 X 10 ⁻⁴
Gollsur 4th midrib	0.719	7.105 X 10 ⁻⁴	0.937	3.854 X 10 ⁻⁴
Prelip 2nd	1.204	2.309 X 10 ⁻⁴	1.450	1.254 X 10 ⁻⁴
Prelip 2nd midrib	0.698	7.450 X 10 ⁻⁴	0.985	3.282 X 10 ⁻⁴
Prelip 4th	0.957	3.934 X 10 ⁻⁴	1.083	2.770 X 10 ⁻⁴
Prelip 4th midrib	0.910	4.191 X 10 ⁻⁴	1.091	2.388 X 10 ⁻⁴
Chamchamal	1.197	2.397 X 10 ⁻⁴	1.413	1.303 X 10 ⁻⁴
Chamchamal midrib	0.822	6.243 X 10 ⁻⁴	1.156	2.198 X 10 ⁻⁴
Pishdar	1.209	2.904 X 10 ⁻⁴	1.514	1.314 X 10 ⁻⁴
Pishdar midrib	0.793	7.115 X 10 ⁻⁴	1.095	2.934 X 10 ⁻⁴

2nd = Second priming ; 4th = Fourth priming

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ظاهرة المنحنيات الحرارية للامتزاز الرطوبي في التبوغ الشرقية الجففة

١- سلوك الفعالية المائية والتخلف

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الخلاصة

يمكن الحصول على معلومات قيمة من خلال اختبار المحتوى الرطوبي لاوراق التبغ وعلاقته بالظروف المناخية ، خصوصا خلال مراحل المعاملات المختلفة ، تم دراسة المنحنيات الحرارية للامتزاز الرطوبي للتبوغ المزروعة محليا . اختلفت اوراق اصناف التبغ من ناحية سلوك الفعالية المائية . كانت قيم المنحنيات الحرارية للامتزاز الرطوبي للعرق الوسطى اعلى من النصل . لوحظ وجود تأثير واضح لدرجات الحرارة على المنحنيات الحرارية للامتزاز الرطوبي . بينت الدراسة تواجد ظاهرة التخلف بوضوح . تفاوتت الاوراق في ما بينها من ناحية ظاهرة التخلف .

دياردهی هیلی چه ماوهی هاوگرمی مژینی شن له توتنی رۆژهه لاتی ووشکراو
١/ ره فتاری چالاکئی ناوودواکهوتن .

نوميد نوري محمد امين

بهشی بهروبو می کیلگهی - کولنجی کشت وکال - زانکوی سلیمانی

کورتیه

ته توانی زانیاری به نرخ داین بکریت له تاقی کردنهوهی رۆژهی شن له گه لای توتن وه په یوه ندی دۆخی کهشی ، به تابه تی له ماوهی کرداری جیاواز . لیکولینه وه نه بنجام درا له بابهت هیلی چه ماوهی هاوگرمی مژینی شن له توتنی چاندرایی خومالی . جیاوازی ده رکته له تیوان توخمی توتن له بابهت شیوازی چالاکئی ناو . بههای هیلی چه ماوهی هاوگرمی مژینی شن له ده مازدا زینا تر بوله له بی گه لادا نه بنجامی کاری پلهی گه رمایی تاشکرا پینراو له سهر هیلی چه ماوهی هاوگرمی مژینی شن . لیکولینه وه که روونی کرده وه که دیاردهی دواکهوتن تاشکرایه گه لاکان جیاواز بوون له دیاردهی دواکهوتن .