DEPENDANCE OF YIELD OF SUNFLOWER HYBRID SEED ON ENVIROMENTAL FACTORS AND INSECTS

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INTRODUCTION

The production of sunflower hybrid seed depends on genetic compatibility or incompatibility of parental components as well as on environmental factors. Certain genetic potentials for yield of parental lines will be realized successfully only in favorable environmental conditions. Negative effects of the environment are fully expressed at the stage of flowering, when the number of seeds per head, one of the most important yield components, is determined. The percentage of pollination depends on the degree of variability between maximum and minimum daily temperatures and the length of sunny days during the flowering. If these factors are unfavorable, the quality of pollen is lowered (Vranceanu et al., 1978). Other factors which reduce the percentage of pollination are a high relative air humidity followed by high temperatures, especially in early morning (Morozov, 1947; Jain et al., 1978). Frequent rains at the time of the intensive formation of pollen reduce the percentage of pollination because they increase the humidity and leach pollen grains from sunflower heads (Morozov, 1947; Jain et al., 1978). The bees and other pollinizers are important at the time of pollination because they carry pollen from one plant to another. The presence of bees is determined by air temperature, air humidity, and the frequency of bees in seed plots (Low et al., 1978; Cobia and Zimmer, 1975).

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MATERIAL AND METHOD

The material used in this investigation were SC sunflower hybrids based on cytoplasmic male sterility —NS-H-26-RM, NS-H-33-RM, and NS-H-62-RM. They were grown in two localities differing in agroecological conditions to compare the efficiency of pollination. Fifty heads of average size were picked three times in commercial plots of 100-500 ha. Each head was threshed manually; fertilized and empty seeds were counted and their percentages were then calculated. The seeds were measured for hectoliter weight and 1000 seed weight. Meteorological data from the experimental localities and the frequency of bees were analysed in an attempt to determine the causes for the occurrence of empty seeds.

RESULTS AND DISCUSSION

The analysis of variance (Table 1) showed that significant differences occurred in the percentages of pollination both among the hybrids and between the localities.

The differences in seed yield between the localities were 14.07 q/ha for NS-H-26-RM and 2.56 q/ha for NS-H-33-RM. NS-H-62-RM showed no differences. The yields of NS-H-26-RM were highly variable the yield in the locality I reached the lower limit of genetic potentials for yield of cms lines (12.29 q/ha); conversely, the yield in locality II was 26.36 q/ha which approaches the upper limit of genetic potentials for yield. This large difference occurred due to a higher variation between the maximum and minimum temperatures in locality I —at the time of full flowering, in the second and third decades of July, there were nine days with the ratios maximum vs. minimum air temperatures ranging from 2.5:1 to 3:1 (Graph 1a), which affected the vitality and fertility of pollen. At the same time, there were 10 rainy days and 25.1 mm of rain, as opposed to six rainy days and 30.0 mm of rain in locality II. Since there was a smaller number of rainy days in locality II, the leaching of pollen did not occur (Graph 2a). The relative air humidity in the second and third decades of July in locality II was higher by 2% than in locality I whereas the temperatures were the same. It was characteristic for these two localities that the relative air humidity in the second and third decades of July was higher by 7.6% In locality II than in locality I while the values of the average mean relative air humidity for July were not much different 70.0:72.2% The relative air humi-

dity was more variable in locality I than in locality II —58-93% and 60-92%, respectively (Graph 3a).

The mean daily temperatures in the second and third decades of July were more variable in locality I than in locality II 16.1-25.3° C and 17.6-24.6° C, respectively.

In the process of pollination of sunflower hybrid seed, where the mother component is cytoplasmically male sterile, the presence of bees and other pollinizers may be very important. In locality I, there were 0.42 bee families per 1 hectare while in locality II there were 1.07 bee families. A larger population of bees and better climatic conditions in locality II were decisive for a higher percentage of pollination (86.4%) and thus for a higher seed yield.

Graph 4a shows the percentages of empty seeds in localities I and II. In locality I, the distribution of empty seeds was rather uniform, with a tendency of increase of empty seeds with the increase in the percentage of unpollinated seeds. The situation was opposite in locality II —the largest number of plants had 10-20% of empty seed and only a small number had 20-30% of empty seeds.

NS-H-33-RM had different percentages of pollination and seed yields in different agroecological localities. In localities I and II, the percentages of pollination were 65.4 and 85.8%, respectively, while the seed yields were 17.01 and 14.45 q/ha, respectively. The mean temperatures in July affected the pollination although the temperatures did not differ much —19.4 and 20.2° C, respectively. However, considerable differences were found in mean daily temperatures and the ratios maximum vs. minimum temperatures for the second and third decades of July (Graph 1b). Although the difference between the mean daily temperatures was small, only 2.5° C, the differences between maximum and minimum temperatures were considerable. In locality II, the absolute maximum and minimum for the second and third decades of July were 30.8 and 10.7° C, respectively. In locality I, the mean absolute maximum and minimum were 30.0:10.5° C for the second decade of July and 36.5:10.0° C for the third decade of July. These large temperature variations which exceeded the ratio 3:1 affected the vitality and fertility of pollen and decreased the total pollination. In locality I, there were 10 days with the temperature ratio 3:1 in the second and third decades of July; in locality II, such a high ratio did not occur at all. High temperature variations in locality I were accompanied by a high relative air humidity which increased the moisture but decreased the activity of pollen which in turn resulted in a reduced pollination (Graph 3b).

In the second and third decades of July, locality I had the relative

air humidity higher by 5% but smaller precipitation and number of rainy days than locality II (Graph 2b). There were 7 bee families in locality I which improved the pollination in spite of extreme temperatures and relative air humidity. In locality II, the number of bees was negligible but the presence of other pollinizers and favorable environmental conditions brought higher values of pollination than those for locality I. NS-H-33-RM and NS-H-62-RM had similar yields in spite of different percentages of pollination obtained in the experimental localities. The explanation is that the period from pollination to maturation was more favorable for seed filling and dry matter accumulation in the locality which had inferior pollination. It is obvious that this period of sunflower vegetation affects the yields of hybrid seed.

With NS-H-33-RM, the frequency of empty seeds was similar in both localities although the highest percentage of empty seeds was similar in both localities although the highest percentage of empty seeds was 40-50% in locality II whereas the percentage reached 70-80% in locality I (Graph 4b).

The reaction of NS-H-62-RM to environmental factors of the experimental localities did not differ from those of the other hybrids. The percentages of pollination were affected by the relative air humidity and the variations in humidity between the localities. The ratios maximum vs. minimum relative air humidity in localities I and II were 94:58% and 79:64%, respectively (Graph 3c).

Although localities I and II differed in the percentages of pollination (70.6 and 94.6%, respectively), the yields did not differ as the result of a very favorable period of seed filling in locality I. With NS-H-62-RM, largest number of plants had 5-10% of empty seeds in locality I and 20-30% of empty seeds in locality II (Graph 4c).

The analyses of 1000 seed weight and hectoliter weight (Table 2) showed that the percentage of pollination and 1000 seed weight were negatively correlated. Hectoliter weight increased with the increase in pollination although it depended also on other factors, primarily on the success of the stage of seed filling.

ABSTRACT

The process of pollination in the sunflower, a typically open-pollinating species, is affected by environmental factors and by the presence of bees and other pollinizing insects. In different agroecological regions, unfavorable environmental factors may reduce the total

pollination up to 40%. In our case, the percentage of pollination varied between the localities as well as among the hybrids grown in the same locality. NS-H-26-RM had the pollination of 55.6% in locality I and 89.2% in locality II. NS-H-33-RM had the pollination of 69.4% in locality I and 85.8% in locality II. NS-H-62-RM had the pollination of 80.4% in locality I and 94.4% in locality II.

A reduced pollination decreases the yield of hybrid seed. NS-H-26-RM had the yield of 12.29 q/ha in locality I and 26.36 q/ha in locality II; NS-H-33-RM had the yield of 17.01 q/ha in locality I and 14.45 q/ha in locality II; NS-H-62-RM, in spite of a significant difference in the percentages of pollination, had the yield of 16.7 q/ha in locality I and 16.73 q/ha in locality II. The reason for it were outstandingly unfavorable climatic conditions at the stage of seed filling in locality II, i.e., high air temperatures, a low relative air humidity, and the shortage of soil moisture.

The essential factors which affect the production of hybrid seed are the air temperature, 30/10° C ratio between maximum and minimum temperatures, the mean daily temperature around 20° C, the ratio highest vs. lowest relative air humidity 95:55%, the level of precipitation, number of rainy days, cloud canopy, and water provision of soil. The presence of bees and other pollinizers may increase the percentage of pollination which, in turn, brings higher seed yields.

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TABLE 1

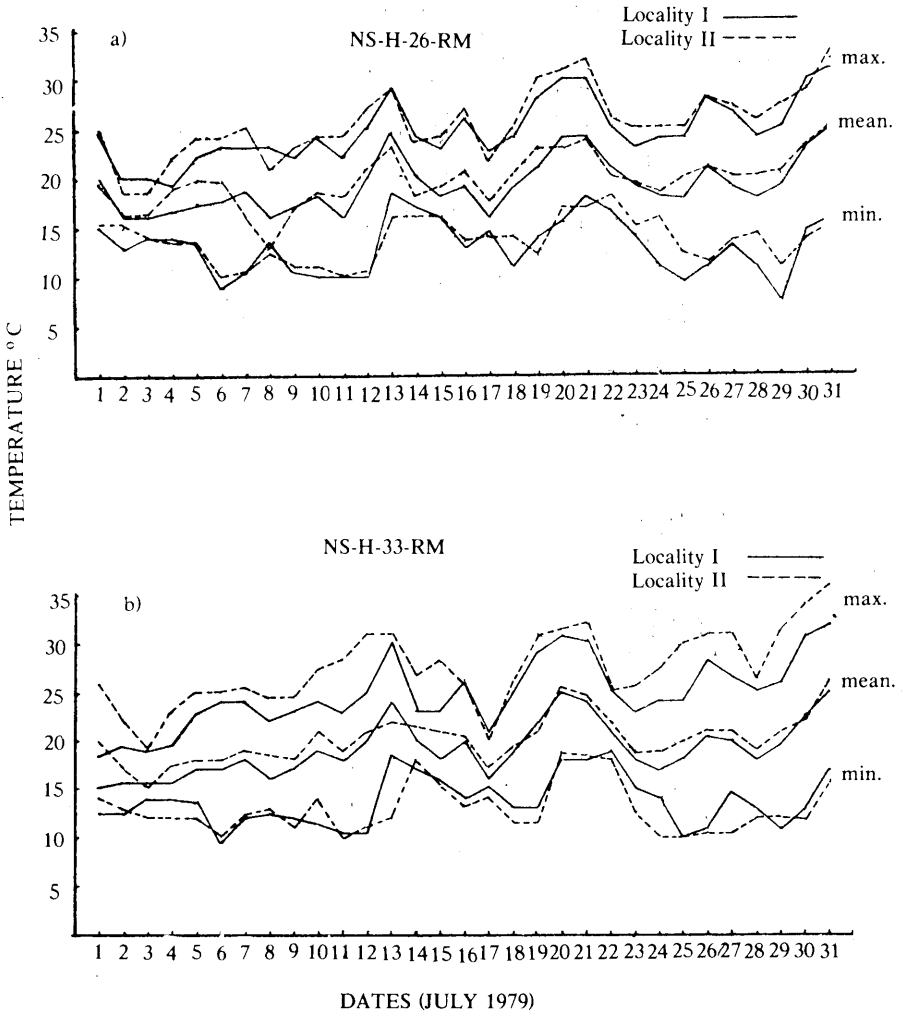
Dependance of yield of sunflower hybrid seed on environmental factors and insects

Hybrid	Locality	Replication			Average
		I	II	III	
NS-H-26-RM	Locality I	55.6	40.5	40.4	45.5
	Locality II	89.2	82.4	87.7	86.4**
NS-H-62-RM	Locality II	94.4	93.2	96.3	94.6**
	Locality I	80.4	72.0	59.4	70.6
NS-H-33-RM	Locality I	69.4	64.0	69.6	67.7
	Locality II	85.8	89.1	83.4	86.1**
LSD	For Hybrids 5% = 11.6% 1% = 19.3%			For Localities 5% = 12.0% 1% = 18.2%	

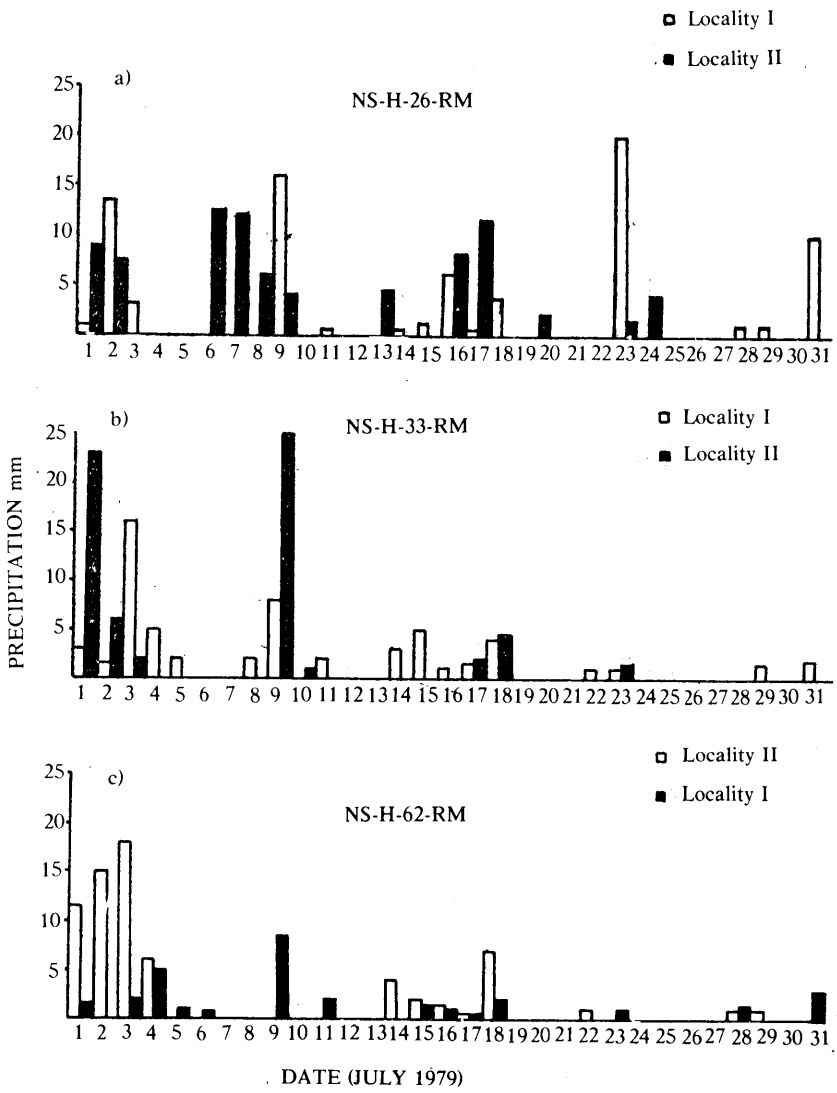
TABLE 2

Effect of ecological factors on yield, 1000 seed weight, and hectoliter weight of sunflower hybrid seed

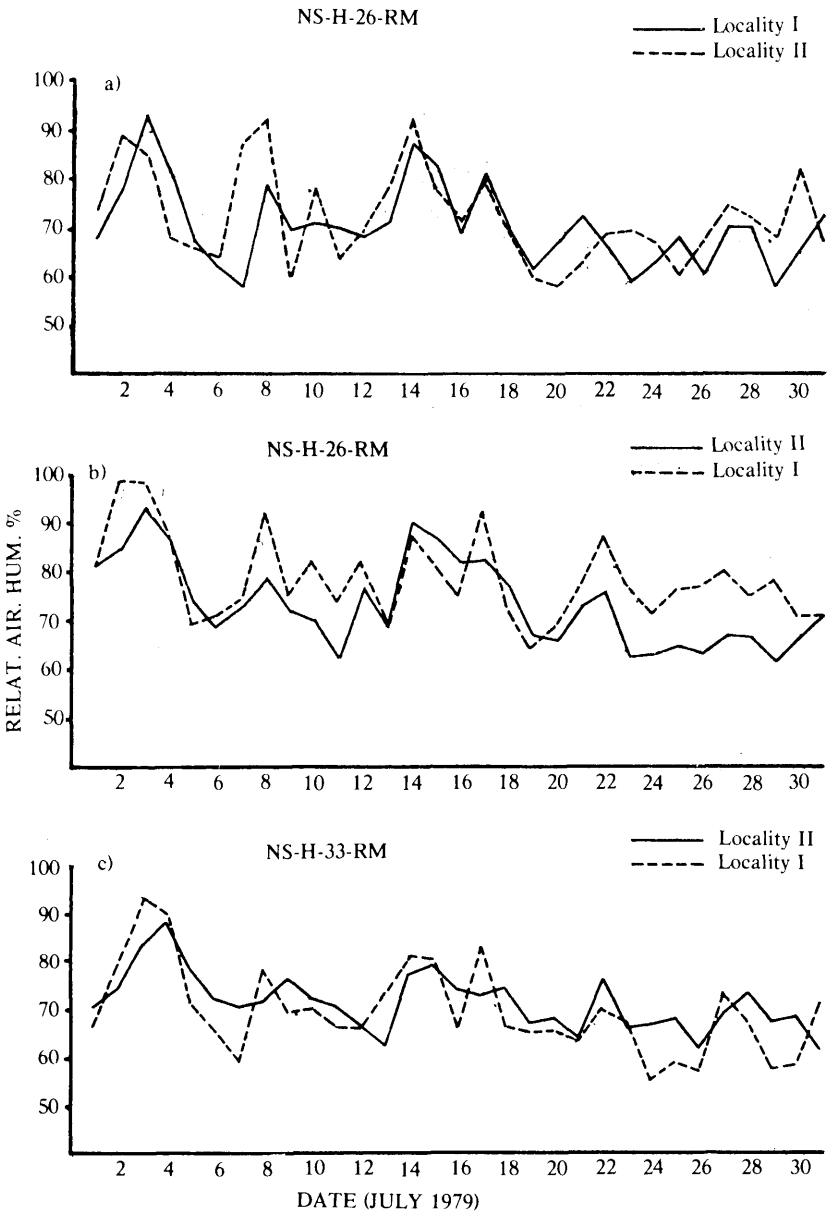
Hybrid	Locality	Average yield q/ha	1000 seed weight	Hectoliter weight
NS-H-26-RM	Locality I	12.29	144.7	41.7
	Locality II	26.36	96.7	42.2
NS-H-33-RM	Locality II	14.45	107.1	39.8
	Locality I	17.01	92.1	43.4
NS-H-62-RM	Locality II	16.73	96.9	47.5
	Locality I	16.70	105.4	41.1



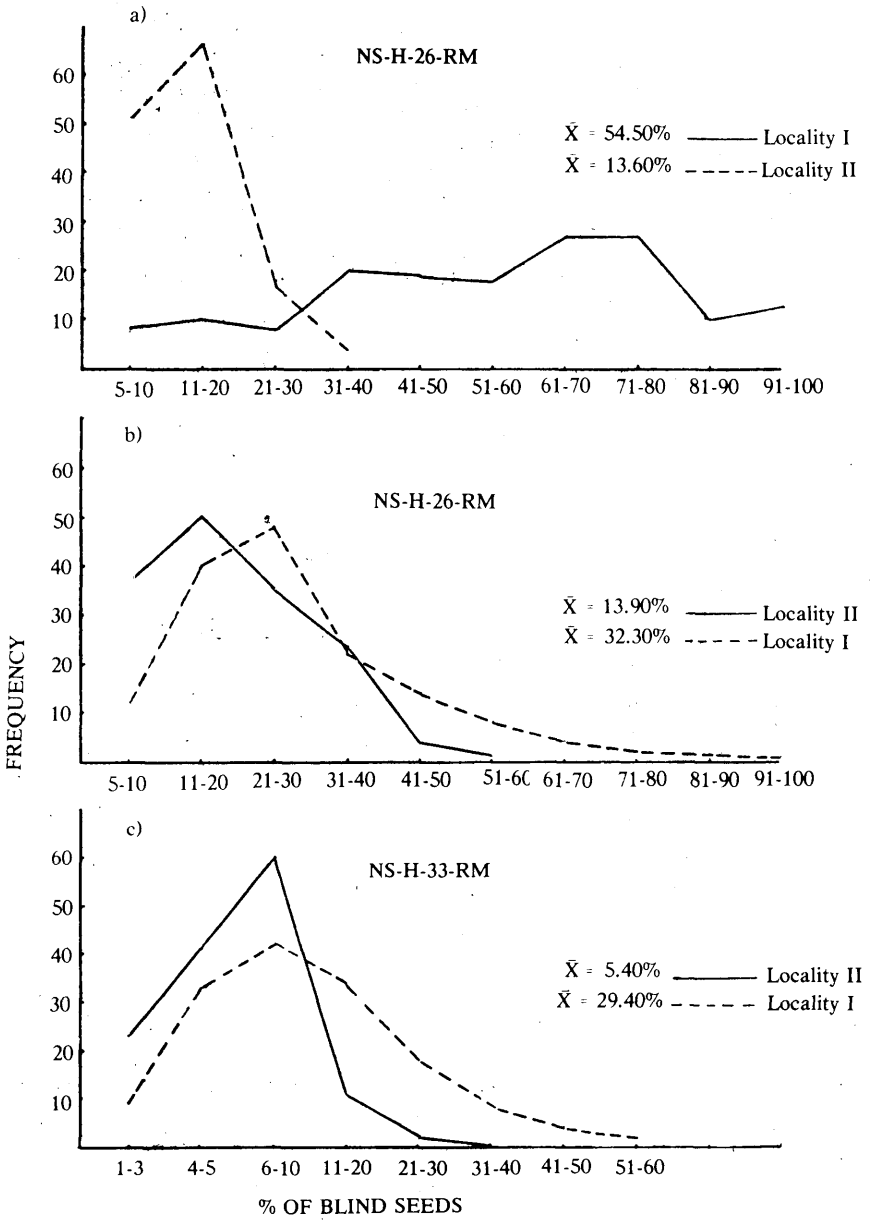
Graph 1.— Effect of temperature of sunflower pollination.



Graph. 2.— Effect of precipitation and number of rainy days on sunflower pollination.



Graph. 3.— Effect of relative air humidity on sunflower pollination.



Graph. 4.— Frequency of blind seeds depending on percentage of sunflower pollination.