COCKSFOOT BREEDING.

A DISCUSSION ON SOME GENETICAL DATA,

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Professor Stapledon, working with Cocksfoot, has shown that ecoty-pes offer favourable material on which to commence breeding strains suitable for a particular habitat. With that material and simple selection considerable progress may be made without a rational understanding of the genetic fundamentals underlying the results, The object of this paper is to discuss some genatical data relative to Cocksfoot breeding and to include information emphasising the importance of a knowledge of the genetic make up of the individual.

SELF AND CROSS FERTILITY.

The methods by which self fertilised plants can be improved are simple and easily understood, In contrast to this the normally cross fertilised plants, if propagated by seed, demand more complicated methods, which vary according to the degree of self fertility it is possible to induce. Workers in ether countries have presented varying results on self fertility in Cocksfoot ranging from complete self Sterility to self fertility. Professor Stanledon who has collected data from about 1,200 plants summarises the position (Series H. No.12, 1931) as follows:- "On the average cross-pollination is probably about six to ten times as effective as self-pollination..... the capacity for self fertility varies over the widest margin when individual plants are considered, " The kind of result one gets when self-pollinating Cocksfoot plants is shown in the following, list which gives the number of offspring which mere obtained per panicle by selfing a number of different plants in the season 1933-34:-- 20, 0, 5, 80, 30, ✍✍5, 2, 4, 1·4, 16, 2, 3·6, 1·4, 5·6, 20, ·8; the average is 11·4 offspring ner panicle compared with over ✍✍✍✍✍ ffagr&ng per panicle from cross-pollination under similar pollinating conditions.

Among the L1, of a partially self fertile plant there is apparent segregation of self fertility. From ten sister plants the following number of offspring were obtained per panicle:-- 4, 2, 1·5, 1 6, 2, 3·6, 1 ·4, 5·6, 20, 16.

Sister x brother (sib) pollinations between pairs of these L1 plants were highly fertile giving over 100 offspring per panicle with the exception of one pair which gave only 6 per panicle.

while the above data are insufficient for critical genetical interpretation the three facts, viz.,

(1) differences in degree of self-fertility in different plants,

(2) apparent segregation of self fertility among offspring.

and (3) incompatability between sister and brother in some pairings and not in others.

lend support to the hypothesis that self fertility in Cocksfoot is to some extent an hereditary character,

THE EFFECTS OF INBREEDING.

(a) GENERAL:

The first critical inbreeding experiments on cross-pollinating plants was carried out by East, Shull, Hayes; Jones, and others on maize. Their conclusions may be stated briefly as follows:--

1. Recessive characters) many of which are lethal or undesirable, are exposed.
2. There is an increase in homozygesity with the production of pure breeding sub strains.,
3. There is a reduction in vigour. This is greater the more heterozygous the original plant and it continues until homozygosity is reached,
4. Vigour can be regained by outcrossing inbred strains.

.The first and second of these are of assistance to the breeder of cross-pollinating plants; the third is a hindrance, while the fourth offers a means of overcoming this hindrance,

(b) COCKSFOOT:

In order to ascertain whether the results of inbreeding on maize are applicable to Cocksfoot, breeding. technique of a similar nature is adopted. In self fertile plants self fertilisation is practlsed whereas in self sterile plants the 'so-called diallel method is used, e.g., A x B; B x C; C x A.

As the chances are that any Cocksfoot plant is a hybrid reliahce must be placed on the behaviour of the offspring in assessing the genetic constitution of the parents. By this means recessive characters are exposed. Many of these are lethal, such as forms of Chlorophyll deficiency while ethers may be associated with deformities, dwarfism etc.'

(i) Appearance of Recessives: Jenkin has described the hereditary basis and mode of inheritance of a chlorophyll deficiency in ryegrass and it is probable that chlorophyll deficiency in Cocksfoot also has an hereditary foundation. In our work-from *twenty* six unrelated plants, five L1 families produced chlorophyll deficient seedlings in the following proportions:-- 1 out of 35;1 out of 9; 2 out of 55;1 out of 200; 1 out of 1 5.

In a family of sixteen L1 sister plants four of them produced chlorophyll deficient seedlings in the L2 generaticn-in the following proportion:- 6out of 28; 9 dut of 102; 5 cut of 80; 1 out of 80; while the remaining twelve families pro-' duced green plants ouly. 'It is apparent that segregation of chlorophyll deficiency is taking place here,

The above examples suggest very strongly that a recessive character has been brought to light by the process of inbreeding and this emphasises the desirability of progeny tests in exposing both useful and undesirable recessive characters. Without progeny tests desirable ones will be overlocked and undesirable ones perpetuated.

(ii) Hybrid Vigour: One of the disadvantages which may have to be overcome as a result of inbreed&g is depression of vigour which is frequently associated with inbreeding.

In most L1 families this depression in vigour is noticed though it varies with different plants. The following four plants selfed and, crossed in the same year gave the following yields in the L1 and F1.

					Percentage reduction from selfing.
231	xe23ed	F1	60 grs	(average of 48 plants)	35.5
			"	" " 48 "	
			73,5"	" " 9 "	
94	xe23ed	F1	105 "	" " 45 "	31.1
260	selfed	L1	82.7"	" " 32 "	
260	x 23	F1	111.1"	" " 48 "	26.1
257	selfed	L1	67.3"	" " 31 "	
257	x 200	F1	111.5"	" " 46 "	40.0

In each instance the average of the L1 offspring shows a depression in vigour when compared with cross fertilised off-: spring-, and individuals vary in the amount of the depression which results.

The following table shows that while the average of the L1 shams the depression in vigour there is segregation within the L1 family, some yielding as high as the parent but others much lower. The yields given are. the average of twenty plants grown from equal sized tillers.

PARENT		OFFSPRING									
		1	2	3	4	5	6	7	8	9	AV.
C23	571 grs.	576	474	374	485	469	444	519	502	455	489
C13	638 "	429	630	553	534						536

Thus in these two L1 families in the few offspring tested there was a depression of 14.5% for strain C23 and one cf 16% for strain C13. Within the offspring, however, there is segregation as regards vigour. I have no data to present on the yields in subsequent L generations, but Professor Stapledon says. that there is little or no evidence in favour of 'further decrease in vigour from the L1 to L5generation (Series H. 12. p.178;1931)

The depression in vigour from selfing might be serious'.' in some families and the method suggested to overcome this is to cross inbred families after homosygosity is reached and undesirable characters have been eliminated. Owing to thk fact that the different inbred families will have different genetic constitutions it is advisable to ondeavour to obtain some information as to which hereditary characters will combine to give the greatest vigour and at the same time keep the type relatively constant. While inbreeding is proceeding; then parent plants ordifferent L plants are crossed and their progeny studied to 'determine the best combinations. The effect of different combinations is seen from the following list of crosses where plant 23 was 'crossed with fourteen other plants,

The yields are expressed in terms of C23 shelter pollinated = 100,

23	x 160	90.1
	x 146	89.0
	x 117	111.0
	x 200	89.0
	x 95	84.4
	x 49	88.0
	X 55	85.0
	x 214	124.0
	x 231	93.0
	x 65	104.0
	x 260	92.0
	X 60	121.2
	x 147	110.1
	x 258	104.0

The parent plant in each cross was. selected because of its vigour and type. The yields from the different crosses indicate clearly that the hereditary make up of some plants combine better with Strain C23 than dc others, and their inbred families arc likely to-give higher yields in combination with inbred C23 than are inbred families from the other plants,

DISCUSSION,,

Data are submitted to. support the fact that Cocksfoot is normally cross-pollinating, but is self fertile to a varying degree and that individuals may be highly self fertile or self sterile. Evidence is advanced to show that self fertility is to some extent under the control of heredity. Experiments show that necessives, many of which are lethal or undesirable are brought to light by the process of self fertilisation which is intensive inbreeding, The association of depression of vigour with inbreeding is discussed. Data are presented to show the extent of and segregation of the depression of vigour and also 'the effect of different combinations of heredities on yield,