Hollow Heart

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Most of you are familiar with the appearance of hollow heart. However, for those of you who did not have the appearance of hollow heart permanently imprinted on your memory this past summer, I would like to give a brief description of the stages of hollow heart development as given by Levitt.

The symptoms of the physiological disorder first appears as a small patch of brown dead pit cells surrounded by several layers of practically starch free cells. The dead cells are later surrounded by a layer of cambium cells several layers deep. As the tuber enlarges, a cavity surrounded by collapsed dead cells develops. The hollow heart cavity enlarges mainly in short axis of the tuber rather than along the pith and on reaching full size is completely surrounded by large sausage-shaped cells.

An attempt was made this past summer to separate hollow heart potatoes from sound ones. Separation by specific gravity was tried because light or x-ray detection methods would not handle the needed volume. A schematic diagram of the separator used is presented in Fig. 1. The potatoes were dumped on a slotted incline (A), potatoes having a specific gravity lower than that of the brine were removed by the upper chain (C) and potatoes having a specific gravity greater than that of the brine were removed by the lower chain (B). The brine was circulated in the direction of the arrows to facilitate movement of the tubers.

Separation by specific gravity to obtain a maximum of 5% hollow heart would classify 250-450 lbs of sound potatoes per ton of potatoes run as hollow heart (Fig. 2). Using a group of 70 count potatoes having an initial hollow heart of 48%, 63% of the total initial weight would have to be removed in order to meet grade. About 30% of the initial weight of field run potatoes would be removed when the initial hollow heart was 15% to meet grade.

A laboratory study was conducted to determine the cause of removal of 10-25% sound potatoes with the ones having hollow heart. The specific gravity, weight and presence of hollow heart of each tuber in a 96 lb sample are presented in Fig. 3.

Hollow heart was more prevalent in larger tubers and tubers having hollow heart were usually lower in specific gravity. However, if the specific gravity of a brine solution was set so that only 5% hollow heart tubers would sink (SG 1.069), 35% of the sound tubers would be removed. Thus in this sample containing 48% hollow heart, 78% of the total tonnage would have to be removed to meet grade. This theoretical removal of tubers agrees rather closely with the actual removal from the 70 count sample (Fig. 2). Therefore, the cause of low efficiency in separating hollow heart from sound tubers by specific gravity was due to a wide variation in specific gravity of both hollow heart and sound tubers.

This data and the high cost of light and x-ray separation indicate that, at the present time, there is not an economical method of separating hollow heart from sound potatoes. Thus we must develop some method of preventing hollow heart development in the field.

Before developing a preventative method the time of hollow heart initiation and cause of this disorder should be established. The literature contains considerable controversy as to when hollow heart is initiated; however, most of the literature indicates that hollow heart initiation occurs shortly after tuber set. Conditions which results in rapid foliage growth have usually resulted in hollow heart initiation. Removal of most of the foliage at various periods of plant development has been used to determine when potatoes are most susceptible to hollow heart initiation. The results of two years research conducted by John Schoenemann in Handcock, Wisconsin are presented in Fig. 4. In 1967 and 1968 hollow heart of control plots was less than 3.0% by weight. Removal of 90-95% of the foliage at any date in 1967 resulted in only small increases in incidence of hollow heart. The results in 1968 were quite different. Foliage removal on June 19 resulted in a 27% increase in hollow heart while foliage removal a month later had little effect. Climatological data for two years gives a possible explanation for the differences in hollow heart. Temperature patterns were quite similar for both seasons; however, rainfall was not. In 1967 the June foliage removal treatment was preceeded by a period of relatively heavy rainfall and followed by a period of low rainfall. The rainfall pattern in 1968 was reversed. The heavy rainfall after foliage removal in 1968 may have resulted in one of two situations which have been reported to result in hollow heart initiation. (a) Rapid foliage growth which would cause a drain of some essential nutrient from the tubers resulting in death of some cells or (b) a rapid rate of tuber expansion through hydration which would result in splitting of the tuber. The data in this research is not sufficient to establish which situation resulted in the initiation of hollow heart. The data does indicate that climatic conditions play an important role in incidence of hollow heart.

The range of year to year variation in incidence of hollow heart can be seen from the results of a four year study conducted by Don Nelson in North Dakota with non-irrigated potatoes. The variations in yield, hollow heart and rainfall for the four years were:

	Yield #1	% Hollow Heart	Seasonal Rainfall
1965	200	21	12.1
1966	76	16	11.3
1967	67	0	2.7
1968	169	2	12.6

Results of this study indicate that the incidence of hollow heart can be reduced by proper cultural methods. Plant spacing has considerable effect on incidence of hollow heart (Fig. 5.) Yields were reduced in 1966 by late blight and in 1967 by drought. Drought conditions were probably responsible for low incidence of hollow heart in 1967, but no reason was given for low hollow heart in the 1968 season. Increasing spacing from 12 to 24 inches about doubled the incidence of hollow heart in 1965, 1966 and 1968. Yields were not greatly affected by plant spacing. None of you are using a spacing of 24 inches, but poor stands would have the same effect as wide spacing.

Results presented in Fig. 6 show that hollow heart can be reduced by potassium fertilization. Application of 80 lb K_2O reduced hollow heart of both the 12 and 24 inch spaced plants by about 1/3 in 1965, however, it reduced hollow heart of only the 12 inch spaced plants in 1966. It should be noted that the nitrogen level is much lower than that used in Washington, therefore higher levels of potassium may be required than that used. Several workers have reported that nitrogen increases the incidence of hollow heart. Therefore a balance between nitrogen and potassium may be necessary to achieve a low incidence of hollow heart.

The effect of combinations of cultural practices on incidence of hollow heart is presented in Fig. 7. In North Dakota early planting, close spacing and potassium reduced hollow heart from 45.9% to 5.7% in 1965. A smaller reduction from the same treatments occurred in 1966 and this combination did not reduce hollow heart incidence sufficiently to meet the maximum allowable level of 5% in either year.

Several conditions have been reported to increase the chances of hollow heart. In some cases the conditions are in direct contradiction.

1. Growing susceptible varieties.

2. High soil moisture.

3. High temperature, resulting in vigorous foliage growth.

4. Low temperatures.

5. Poor stands of plants.

6. Poor tuber set.

7. Large tuber set and vigorous vine growth.

8. Low potassium.

9. High nitrogen.

10. Foliage removal, resulting in vigorous foliage growth.

I have begun a research program to determine the stage of development when Norgold Russet potatoes are susceptible to hollow heart and conditions which result in both initiation and development of this disorder.

Fig 1

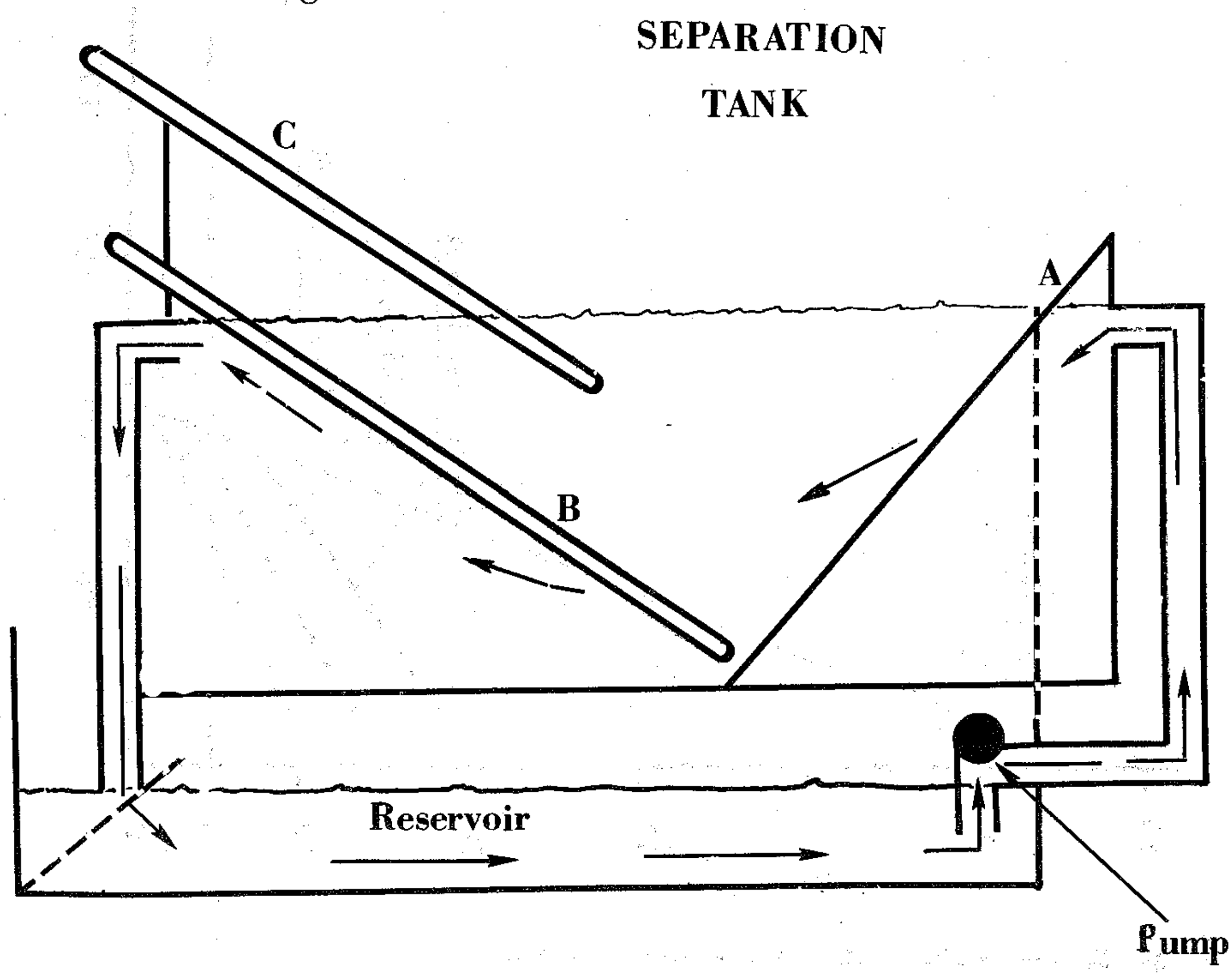
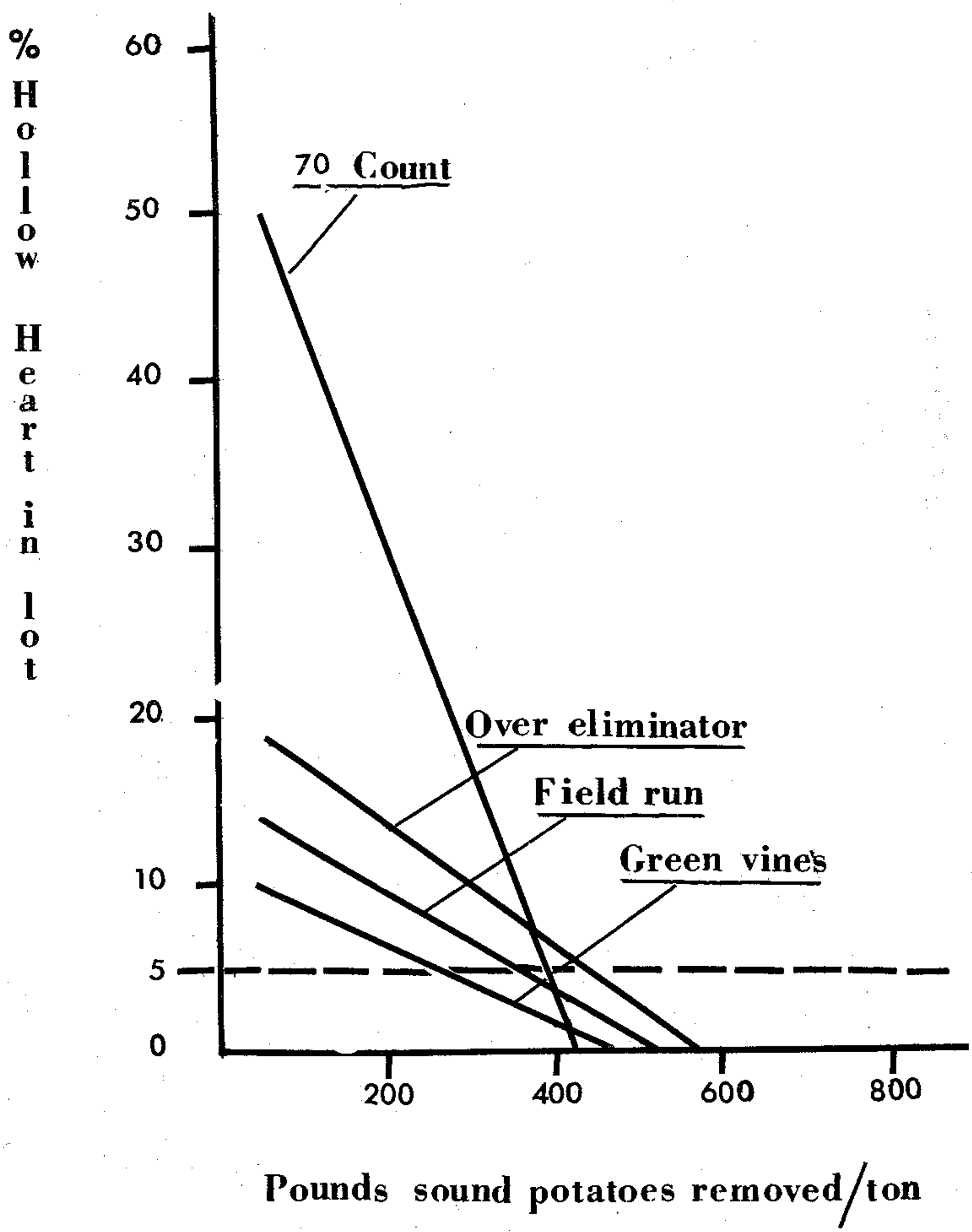
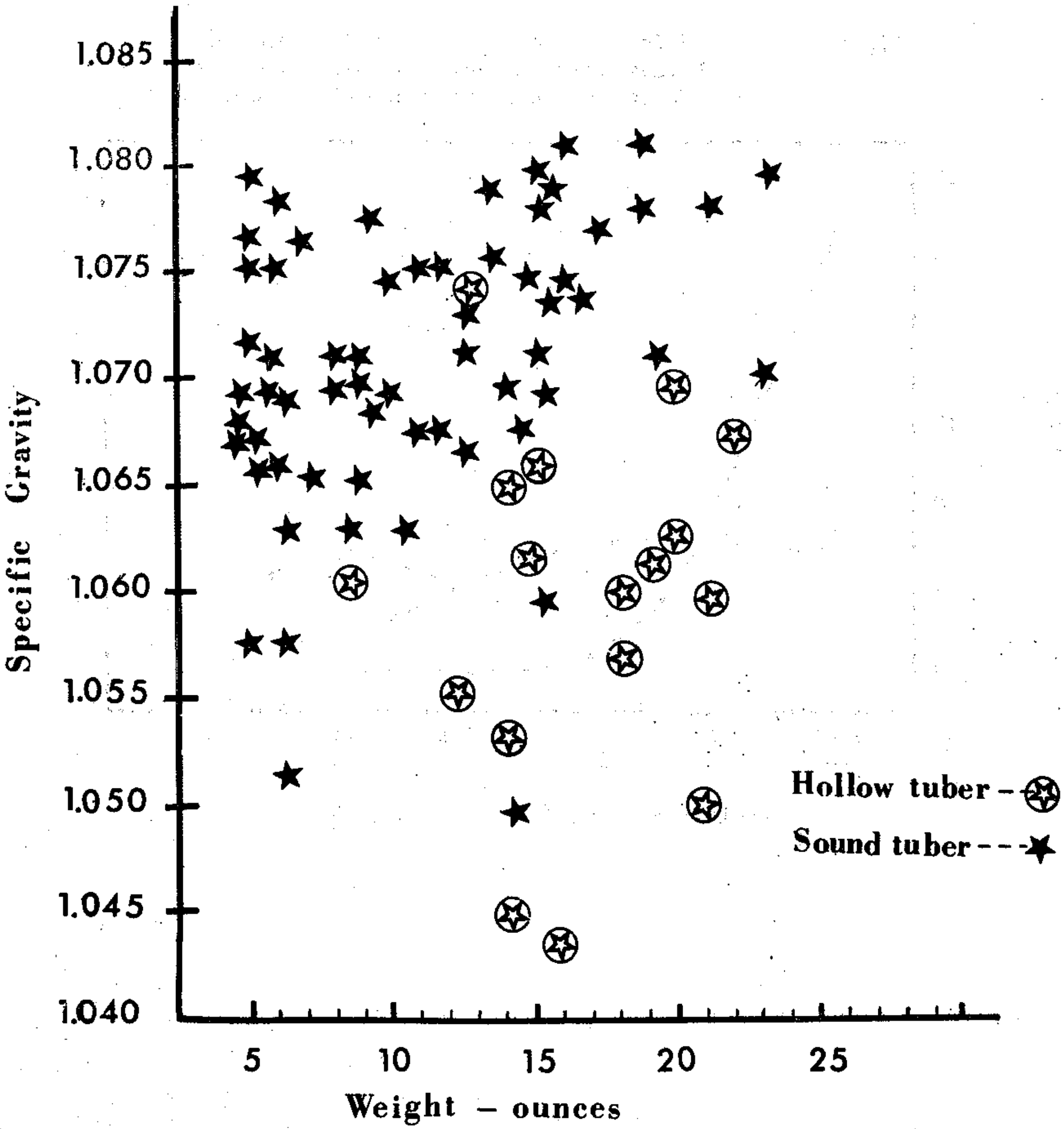


Fig 2


% Hollow Heart in lot
60
50
40
30
20
10
5
0
70 Count
Over eliminator
Field run
Green vines
200
400
600
800
Pounds sound potatoes removed/ton

8/6/69

Fig 3


1.085
1.080
1.075
1.070
1.065
1.060
1.055
1.050
1.045
1.040
Specific Gravity
5
10
15
20
25
Weight – ounces
Hollow tuber
Sound tuber

8-69

Figure 4. Effect of defoliation on incidence of Hollow Heart in Norgold Russet Potatoes (% Hollow Heart is increase above control)

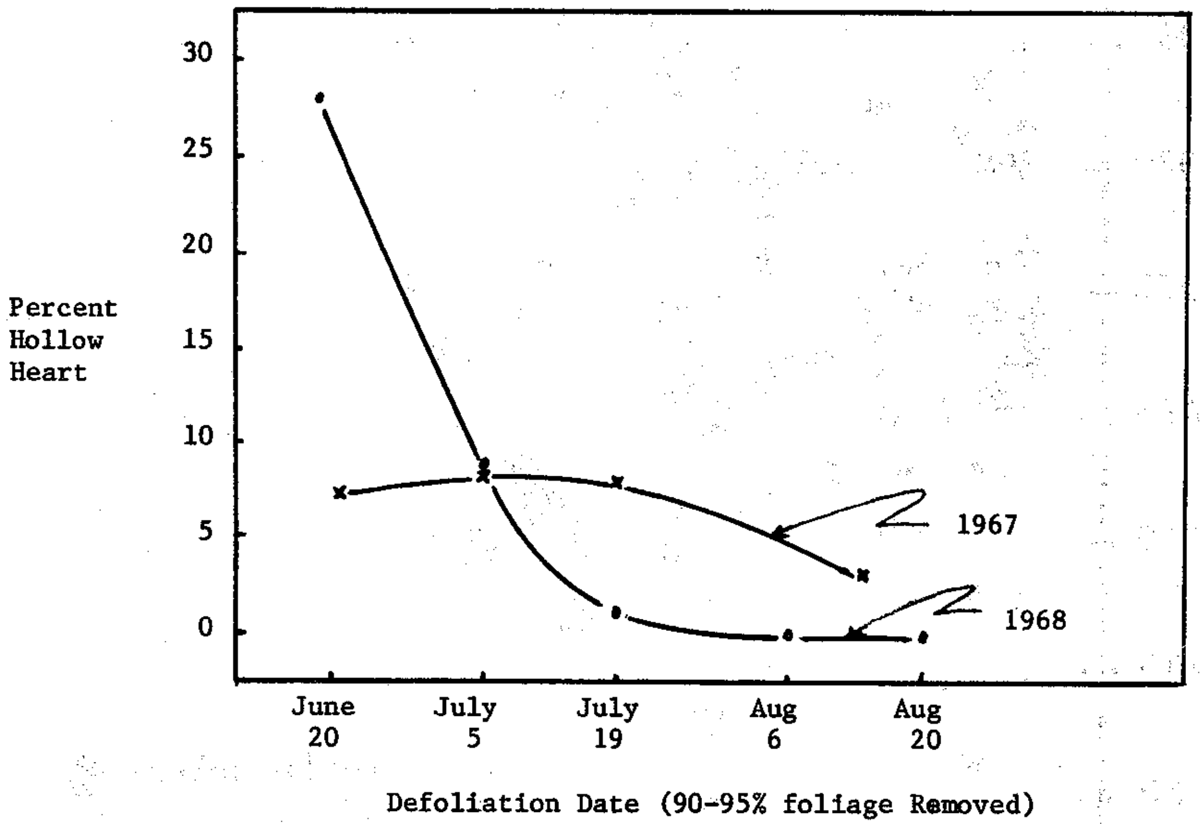


Figure 5. Effect of Plant Spacing on yield and hollow heart of Norgold Russets (Data from D.C. Nelson - N. Dakota)

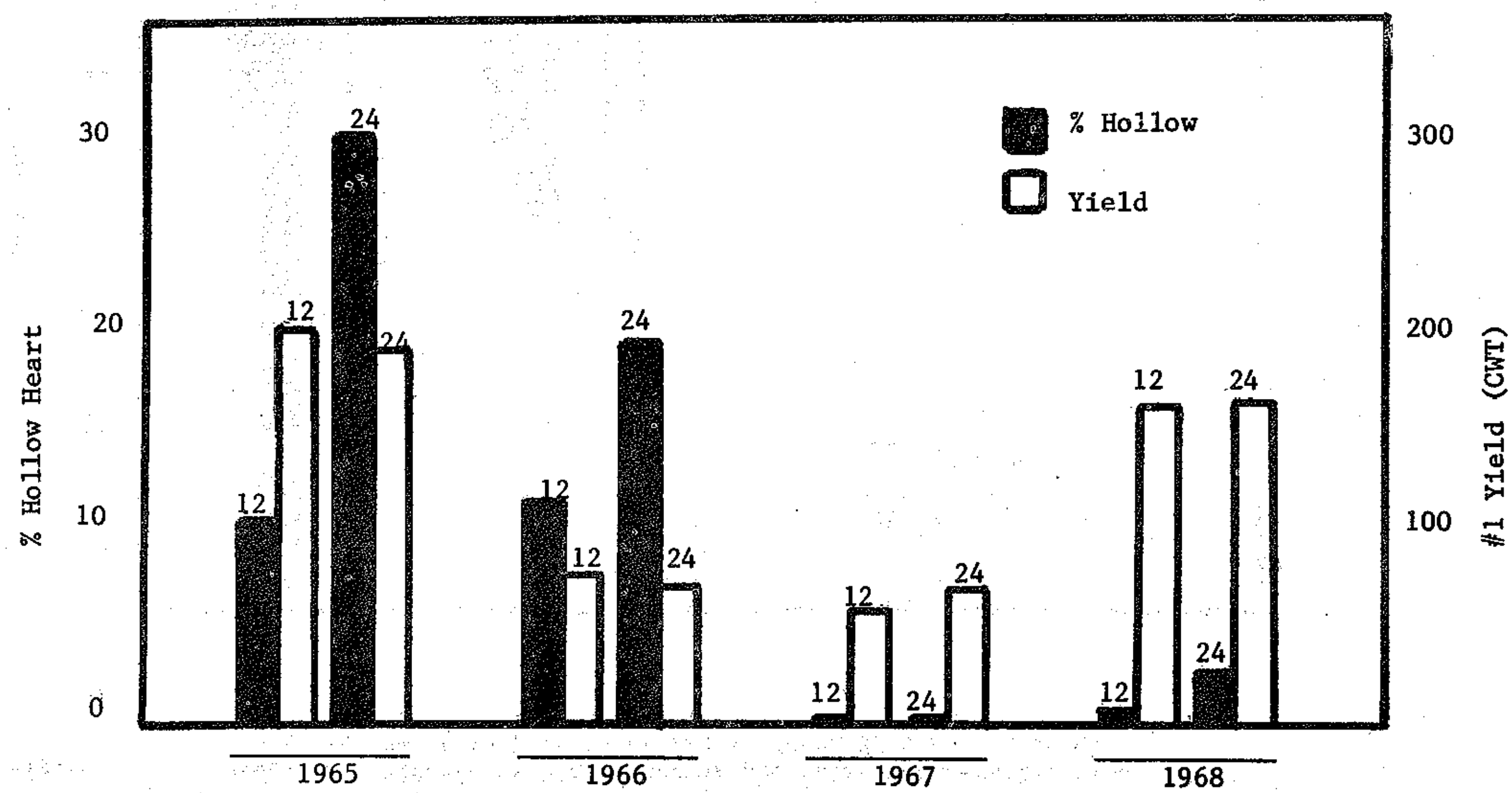


Figure 6. Interactive Effects of Plant Spacing and Potassium Fertilization on Hollow Heart in Norgold Russets. (Data from D.C. Nelson)

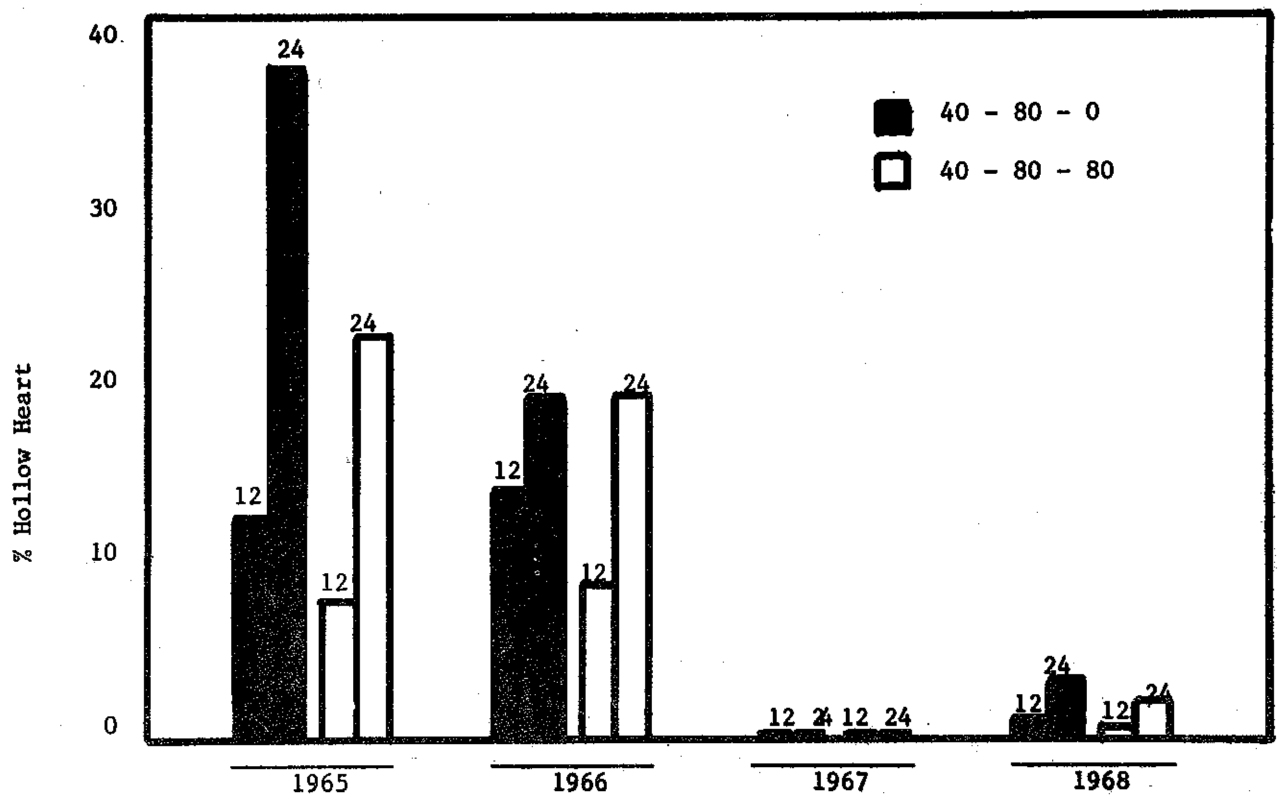


Figure 7. Interactive Effects of Planting Date, Potassium Fertilization and Plant Spacing on Hollow Heart of Norgold Russets (Data from D. C. Nelson)