TRANSLOCATION AND TRANSFORMATION OF CARBOHYDRATES IN POTATO PLANTS.

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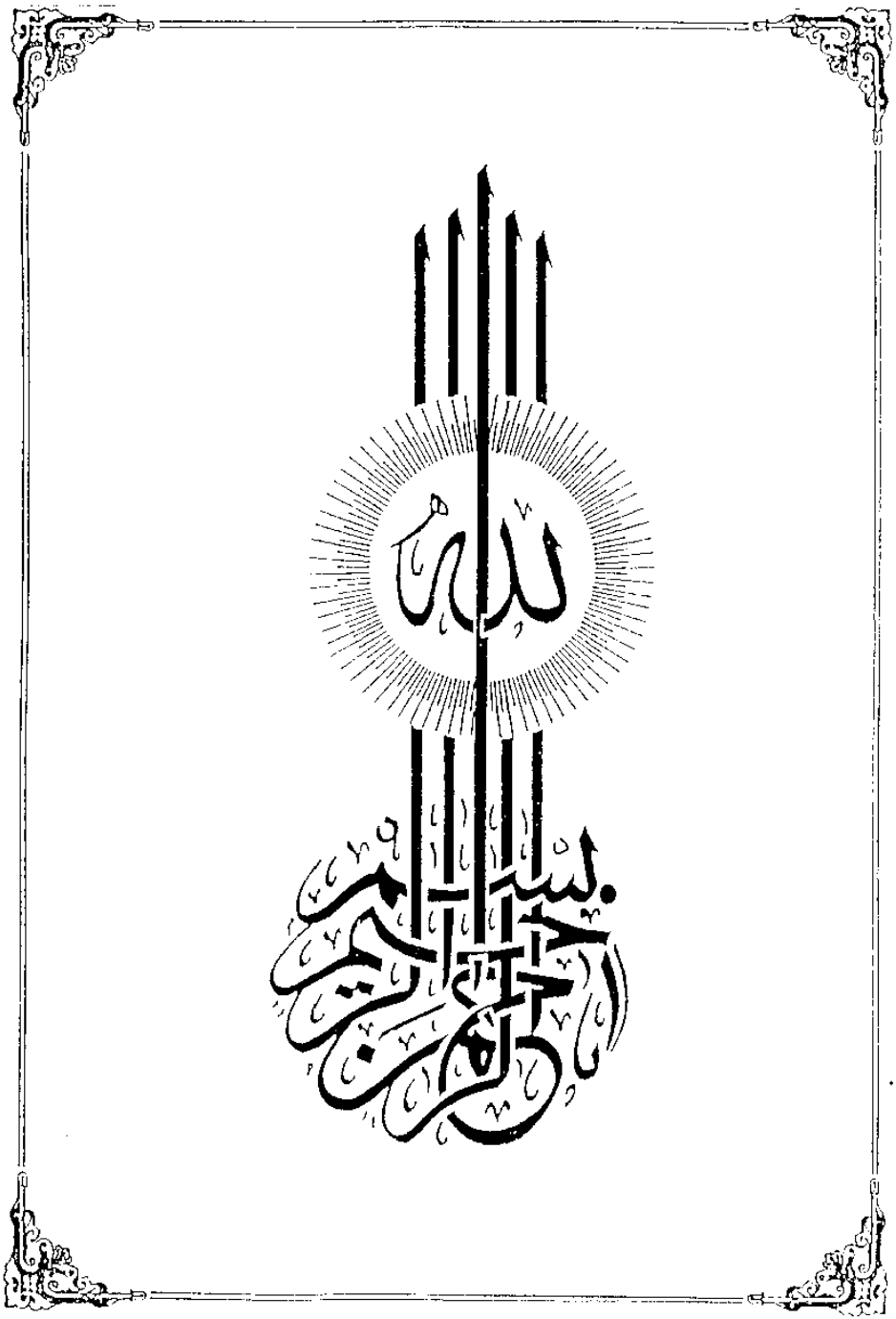

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I N T R O D U C T I O N

The importance of potato in Egypt is coming from the economically point of view that it is considered as the cheapest source for the so called " Carbohydrates " in the form of starch which everybody in the country are in need of it.

In Egypt, potato represents one of the major vegetable crops for export and local consumption. Usually, two crops of potato plants can be cultivated per year. One of them which is known as " Nile crop " is usually cultivated in September and harvested in December, and the second which designated as " Summer crop " is cultivated from January to February and harvested in Summer season.

During the period of maturity, potatoes undergo metabolic changes, the character and extent of which may depend upon the stage of development, as well as the variety. These changes may include variations in carbohydrate contents.

The economic importance of this plant required continual investigations for producing high yield of excellent specific qualities. The majority of the work is directed to the appropriate fertilizer application which is considered as one of the most important factors related to produce higher yields and high starch content in the tubers.

The aim of this investigation is to study the effect of different levels of fertilizer treatments on the yield and carbohydrate fractions in such plant.

REVIEW OF LITERATURE

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A: Carbohydrate fractions of potato tubers :

Singh and Mathur (1937), studying the physiological and chemical changes during the development and ripening of potato tubers, found that the young tubers contained a relatively high percentage of total sugars, reducing sugars and sucrose and a comparatively low percentage of starch. During maturity, the sugars content decreased gradually while starch increased until the vines began to dry. After drying of the vines, sugar contents of the tubers began to rise while starch declined. They also found that the sucrose / reducing sugars ratio rose from 3.4 to 6.0 reaching the highest value when the tubers were making their most rapid growth, and then began to decline. These results were in agreement with those obtained by Appleman and Miller (1926).

Sucrose, glucose and fructose comprise the major sugars of the potato. Trace amount of sugars, chromatographically similar in behavior to keto heptose, melibiose, and raffinose and significant quantity of inositol, have

been detected in the ion-free alcohol -Soluble extracts of the potato tubers (Schwimmer et al. 1954). Vecher and Masny (1966) found that potatoes contained sucrose, glucose, fructose, glucose- 6 - phosphate, fructose - 6 - phosphate, 3 - phosphoglyceric acid and traces of glucose 1- phosphate. The quantitative variations of sugars and their phosphate esters were less in potatoes grown in peat soils than in those grown in mineral soils. Alcohol - soluble sugars are sucrose, glucose, and fructose. Alcohol insoluble fractions include an araban galactan, soluble in 50 % ethyl alcohole, starch, pectin, small quantities of araban - galactan extracted during pepsin hydrolysis (Le Tourneau 1956).

Burton and Wilson (1970) reported that, before tuber initiation the content of reducing sugars in the stolon tips was high, the sucrose content was low and the reducing sugar / sucrose ratio was very high. Tuber formation was apparently associated with a rapid fall in this ratio. The content of total sugars was at maximum (about 1.5 - 3 % fresh weight). One - two weeks after tuber initiation, sucrose predominating. There was no correlation between this maximum sugar content and latitude of

growth. Sugar content decreased as the tubers developed to a final value of 0.1 - 0.3 % total sugars. This was proved by Sowokinos (1971) who studied the relation - ship of sucrose synthetase cleavage activity to the chemical and physical maturity of Norchip and Kennebec potatoes found that, the high percentage of reducing sugars in immature tubers was decreased to approximately 0.05 % by the fourth of August, in both varieties (The approximate time of tuber initiation was July 1 for both varieties). This reduction in the level of reducing sugars per gram of tuber was maintianed for the remainder of the developmental period. He added that the way in which sucrose is converted into starch in potato tubers is still highly speculative. This conversion is of prime importance for developing potato tubers which contain high levels of sucrose that is not hydrolyzed by invertase due to an exess of a specific proteinous inhibitor.

obtained with nitrogen above 120 lb/acre were associated with higher yields of grade tubers. Baerug (1965) showed in 12 trails on sandy soil that potatoes. C.V. Early Puriton, Arran and Pilot sirtoma when given 40, 80, 120 and 160 Kg N/ha., the optimum rate of nitrogen was 120 Kg/ha. in early potato yield. Hanley et. al. (1965) reported that nitrogen application increased total yields of magestic potato. This was clarified by Birch et. al. (1965) who stated that up to 133 units / acre of nitrogen as $(NH_4)_2 \cdot SO_4$ increased potato yields, but there were small depressions at some sites. On the other hand Henderson (1965) found that increased nitrogen reduced total yield. Chapman (1965) recorded that the yield decreased by nitrogen application.

Breuning and Schnieder (1965) found that the application of phosphorus had a little effect on tuber yields but increased starch and dry matter contents as well as their yield in the tubers, these factors were little affected by time of applying phosphorus. Nandpuri and Singh (1966) showed that phosphorus application alone significantly increased total carbohydrates in potato tubers.

(1959) mentioned that the percentage of starch in leaf tissue increased and that of stem decreased with increasing potassium applications. Results of field and pot. experiments of Gisiger (1959) with 30 - 58 % potash salt. " K_2SO_4 " at 120 - 240 Kg/ha. K_2O showed increasing yield and starch content of potato in soils of up to 1.3 mg. % available K_2O supply. On the other hand, Caesar and Ganesan (1964) mentioned that muriate of potash which did not affect yields decreased the starch content of potato.

Arafa (1966) mentioned that the amount of potassium fertilizers utilized in Egypt in comparison to the nitrogenous and phosphorus fertilizers are relatively very low. This does not mean that potassium is of little importance, but rather because of its presonce in ample amounts of an available form in most of the cultivated soils of Egypt. The use of potassic fertilizer in sandy and calcareous soils, particularly these cultivated with bulb crops and vegetable crops is however of considerable importance. Higher yield and the best quality are usually obtained by the use of this fertilizer in such particular soils.

Ellis (1950) found that there is a response in potato yield to potassium application which tended to be accompained by an improvement in grading, while Terman (1950) found no appreciable yield response in soil having more than 100 - 120 pounds of available K_2O. Harrap (1960) mentioned that the optimum rate of potassium application, although differing with different soils, is about 200 lb/ acre K_2O. Pushkarnath et. al. (1962) found that application of K_2SO_4 at rates of 50 - 225 lb/ acre significantly increased yields and increased the size of tuber. The response varied according to the six tested varieties.

Boon et. al. (1962) studied the effect of potassium manuring in five field trails on marino loam soils. He found that application of 500 - 600 Kg /ha. K_2O as KCl with 40 % K_2O was necessary for maximum production on soil containing 0.045 % K_2O soluble in 0.1 N HCl. Above this value responses to potassium were small and sometimes negative. Rowberry et. al.(1963) studied the effect of potassium on the yield of katuhdin potatoes growing at the soils of onteric. He mentioned that while yields were often increased by higher rates of fertilizer yet they were