——— 1936 *Cultivated races of Sorghum.* Allard and Son Ltd., London.

Sonneborn, T. M. 1951 *The Role of Genes in Cytoplasmic inheritance. Genetics in the 20th Century* (291–314) Ed. Dunn, L. C. Macmillan Co., New York.

Sreeramulu, C. 1961 Studies on cytoplasmic male-sterility in *Sorghums* and its economic importance. M. Sc., Thesis Andhra Univ.

Stebbins, G. L. 1958 The inviability, weakness and sterility of interspecific hybrids. *Adv. Genet.*, 9: 147–215.

Stephens, J. C., and R. F. Holland 1954 Cytoplasmic male-sterility for hybrid *Sorghum* Seed Production. *Agron. J.*, 46: 20-3.

Yen, D. E. 1959 Pollen Sterility in Pukekohe Longkeeper Onions. *R. Z. J1. agric. Res.*, 2: 695-12.

https://doi.org/10.29321/MAJ.10.A03651

Dormancy in Seeds and Buds II.*

by

DR. I. M. RAO[1]

Dormancy mechanisms: In an attempt to understand the physiological causes underlying dormancy, detailed investigations were carried out during the current century to correlate dormancy with biochemical changes occurring in the dormant organs. In recent years, the emphasis has passed over to a study of the role of endogenous growth regulators in controlling dormancy and a fairly clear picture seems to be emerging now to explain dormancy.

Biochemical changes during dormancy: Low-water-content (as in seeds), accumulation of reserve substances in insoluble form, low rate of respiration, low enzyme activity (particularly oxidative enzymes), less of sugars and soluble organic nitrogen, *etc.*, are found to be generally associated with dormancy. Results obtained by Baijal (1961), working in association with the present author, on physiological changes occurring in potato tubers under cold storage during the rest period, also reveal a similar relationship between dormancy and rate of respiration, activity of catalase and polyphenolase, sugars, *etc.*, however, it was difficult to locate the completion of dormancy from the above studies alone.

---

* Foundation Lecture delivered at the Agricultural College and Research Institute, Coimbatore, on 20th October, 1967.

[1] Head of the Department of Botany, S. V. University, Tirupati (A. P.)

Detailed investigations were carried out on biochemical changes in dormant and after-ripened peony tree seeds at the Boyce Thompson Institute (Barton, 1961). The differences observed in the chemical composition of endosperm and embryo of dormant and after-ripened seeds are apparent and may not be directly related to the dormancy-breaking process.

Theories to explain dormancy: 1. *Dormancy in light sensitive lettuce seeds:* Coumarin (100 ppm) is known to inhibit germination and induce dormancy in light-sensitive seeds of lettuce while thiourea breaks dormancy in these seeds. Detailed studies on respiration and activity of several oxidases and dehydrogenases as also phytase of the above seeds reveal that significant difference between the treatments is observed only in phytase activity (Mayer and Mayber, 1963). Coumarin appears to affect phosphate metabolism of germinating seeds by retarding phytase activity; inorganic P is thus not available for phosphorylation of sugars; further, coumarin depresses oxidative phosphorylation. Thiourea behaves just in the opposite manner. Coumarin which is present in seeds and other plant parts is included in endogenous germination inhibitors. Coumarin is also observed to interfere with the endogenous balance between growth inhibitors and growth promoters.

2. *Role of Oxygen in dormancy:* Restricted oxygen supply and high temperatures result in secondary dormancy (Vegis, 1964). Decrease in growth activity is attributed to changes in metabolic processes. Glycolysis is accelerated but acetyl Co-A cannot be metabolised rapidly *via* Krebs cycle as oxygen supply is restricted. It results in alternate pathways leading to formation of metabolites which induce resistance to adverse environmental conditions and even inactivation of growth promoting substances.

Henckel (Cited by Vegis, 1964) and his co-workers believe that restricted oxygen supply (known to result in synthesis of lipids) may lead to accumulation of lipid substances on the surface of protoplasm, thus making it impermeable to water and solutes.

3. *Dormancy in rice grains:* Roberts suggests that dormancy in rice grains is due to the active cytochrome oxidase system (as also of other terminal oxidases – polyphenolase and ascorbic acid oxidase) which does not allow oxygen to be freely available for the oxidation of an unknown dormancy inducing substance in the grain. Inhibition of the oxidases results in making available oxygen for the oxidation of the dormancy-inducing substance. Inhibitors of cytochrome oxidase (hydroxylamine, carbon monoxide, cyanide, hydrogen sulphide, *etc.*) favour germination; so also, inhibition of phenol oxidase or ascorbic acid oxidase by cyanide or hydrogen

sulphide. The conclusions are based mostly on the data already available on the effects of respiration inhibitors on breaking dormancy in rice grains. Here again, a substance, similar to germination inhibitor, is assumed to be present in dormant grains, capable of being oxidised in the presence of free oxygen, when the grains germinate.

4. *DNA and RNA:* Recently, changes in contents of nucleic acids are considered to regulate growth (Vegis, 1964). Increases in DNA and RNA are observed during growth, while growth stops, their contents are lowered. Such changes in the mucleic acids are, however, not confirmed by other workers.

5. *Growth regulators:* As dormancy is characterised by cessation of growth, and germination of seeds or sprouting of buds involves growth, it should necessarily involve activity of growth regulators, both of growth inhibiting as also accelerating chemicals. It is known that endogenous inhibitors of growth can be phenols or even cyanide. The former are universally present in plants and so their role in retardation of growth does not appear to be important, although we have already seen that coumarin inhibits germination of lettuce seeds. Cyanide has never been observed in free condition in plants although compounds which can form cyanide on decomposition are known to be present in the plants. Synthetic hormones, NAA, 2, 4-D *etc.*, are known to inhibit germination or growth of buds at suitable concentration. Recently, synthetic chemicals which retard growth have been discovered, *e. g.*, amo 1618 (Wirwillie and Mitchell, 1950); it seems to inhibit biosynthesis of gibberellin (Baldev and Lang, 1965). However, the recent discovery of an endogenous growth retarding substance, Dormin (Abscissin II), revolutionised the concept of dormancy and is rapidly providing clues for understanding the mechanism of dormancy.

6. *Dormin (Abscissin II):* Wareing and his co-workers (1963-'64 and 1965) observed in their experiments on photoperiodism that a chemical substance was formed in the leaves under treatment (short-day) which retarded the growth of the apical buds and even converted the young leaves to bud scales. They could isolate the substance from leaves of Acer which retarded growth of shoots. Cornforth, *et al* (1965, 1965) successfully synthesised the chemical, an isoprenoid, related to vitamin A. It turned out to be the same as Abscissin II discovered by Addicott and co-workers (1965) isolated from cotton fruit. Now it is known that dormin is present, although in very small amounts, in seeds, leaves and many other parts of plants. It is now definitely established that dormin present in barley grain depresses the hydrolysis of reserve carbohydrates.

Varner and co-workers (1965–'66 and 1967) have shown that gibberellin, which promotes germination, diffuses from the embryo to the aleurone layer, where it enables the formation of specific m-RNA molecules which lead to the synthesis of specific enzyme proteins, d-amylase and even proteases. They have also shown that dormin also functions at the m-RNA level, retarding the formation of specific m-RNA. The proportion between the two regulators may decide the direction of the reaction.

Van Overbeek (1966–'67) visualises that during dormancy period of the seed, dormin inhibits synthesis of the specific hydrolytic enzymes, the gibberellin content being very low. By about the end of dormancy or by any treatments, *e. t.*, even washing of the seeds, dormin-content is very much lowered and the endogenous gibberellin increases relatively, leading to the formation of the specific hydrolytic enzymes. He even suggests that cytolytic enzymes may also be formed which weaken or destroy the outer impervious layers. Thus sugars and amino acids, including tryptophan (precursor of IAA) are translocated to the embryo from the endosperm. The synthesised IAA promotes coleoptile-growth. Root-growth is promoted by gibberellin itself. He also suggests that gibberellin, which promotes synthesis of ribonuclease, can make available cytokinins, the degradation products of nucleic acids. Cytokinins act synergistically with IAA in promoting growth besides their specific action in accelerating cell-division. They also help in maintaining normal growth.

Thus, endogenous growth regulators seem to play a major role in dormancy, particularly dormin and gibberellin, the two opposing factors, functioning perhaps at the same level; the result is apparently decided by the balance between the two.

REFERENCES

B. D. Baijal, 1961 *Ph. D. Thesis*, Agra Univ.

Baldev, B; Lang, A; and Agatep, A. O. 1965 *Science.*, **147** : 155.

Barton, L. V. 1961 *Proc. Int. Seed test. Ass.*, **26** : 561.

Borthwick, H. A.; *et al* 1952 *Proc. Nat. Acad. Sci., Wash.* **38** : 662.

Chrispeels, M. J. and Varner, J. E., 1966 *Nature.*, **212** : 1066.

Chrispeels, M. J. and Varner, J. E., 1967 *Pl. Physiol..* **42** : 1008.

Cornforth, J. W., Milborrow, B V. and Ryback, G, 1965 *Nature.*, **205** : 1269.

Cornforth, J. W., Milborrow, B. V. and Ryback. G. 1965 *Nature.*, **206** : 715.

Eagles, C. F. and Wareing, P. F. 1963 *Nature.*, **199** : 874.

Evenari, M. 1949 *Bot. Rev.*, **15** : 153.

Keilin, D. 1959 *Proc. Roy. Soc. B.*, **150** : 149.

Mayer, A. M. and Mayber, A. D. 1963 *The germination of seeds.*, Porgamon press.

Okhuma, K., F. T. Addicot, O. E. Smith and W. E. Thiessen.	1965	*Tetrahedron letters*, 2529.
Pollock, M. and V. K. Toole.	1961	*Year book of Agriculture.*, 106.
Robinson, P. M., P. F. Waroing and T. H. Thomas,	1963	*Nature.*, 199 : 875.
Thomas, T. H., P. F., Waroing and P. M. Robinson.	1965	*Nature*, 205 : 1270.
Van Overbeck, J.	1966	*Science*, 152 : 721.
———	1967	*Intern. Symp.*, Calcutta, India; (in press.)
Varner, J. E., G. R. Chandra and M. J. J. Chrispeels.	1965	Cellular Comp. *Physiol.*, (Suppl 55).
Vogis, A.	1964	*Ann. Rev. Pl. Physiol.*, 15 : 185.
Wareing, P. F., C. F. Eagles, P. M. Robinson, and Colloq.	1964	*Intern. centre. Nat. Rech. Sci., Paris.*, 123 : 377.
Wirwilllie, J. W. and J. W. Mitchell.	1950	*Bot. Gaz.*, 111 : 491.

Studies on the Development of Tubers in Nutgrass and Their Starch Content at Different Depths of Soil

by

J. SAKHARAM RAO [1]

Introduction: Nutgrass ((*Cyperus rotundus* L.) is one of the most troublesome weeds, and this is primarily due to the efficient propagation methods by the hardy subterranean tubers. The degree of tuber development and density of population are however, conditioned by the soil, environment and climatic situations. The present investigation was undertaken to study the tuber development, density of tubers and their starch contents at different depths in cultivated and fallow areas.

Review of Literature: Andrews (1940 a) found the depth of penetration of tubers, to be largely dependant on the moisture relationships of soil as well as the tubers. The above author has investigated the viability of tubers in undisturbed and cultivated areas. Andrews (1940 b) in another study, invesvigated the maintenance of life in nutgrass tubers at different depths, in fallow and flooded soils. In Mauritius, Rochecouste (1956) investigated the distribution and competition of the species in sugarcane

[1] Reader in Plant Physiology, Agricultural College and Research Institute, Coimbatore - 3.

Received on 4—8—1967.