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Editorial

Agronomic Impacts on the Performance of Field Crop Seed (Introduction)

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"Civilisation depends for continuance on the seed saved each year for planting the next". This evergreen statement made by J.F. Cox concerns the importance of seed propagation and the value of crop seed [1]. The forthcoming Special Issue of Agriculture titled "Crop seed dormancy, germination and vigor analysis and seed proteomics" is intended to cover a broad spectrum of issues within the field of seed production. Unlike conventional seed propagation studies, this volume will highlight problematic areas of seed production. The first such area is seed dormancy, which is rather diverse and dependent on crop species and management techniques. The other area addressed in the present volume is dedicated to viability, including all genetic and agronomic factors of germination and vigor. Subsequently, a novel field of seed science is presented, which comprises proteomics and other biochemical characteristics that may influence the success of seed production and propagation. Finally, the abiotic and biotic factors of seed storage and postharvest manipulations will be discussed.

The process of the sexual reproduction of crop plants has long been studied by human societies. Almost all myths, legends, and religious sources provide information on this matter. Three facts have been recorded concerning the sexual propagation of plants as early as the 10th millennia BC: the autotrophic manner of growth and development, the existence of male and female generative organs, and the nature of hereditability.

Throughout human history, agriculturists have developed seed propagation techniques for various field crops. Most of these practices were based on empirical methodologies; however, over time, the use of scientific assessments became increasingly frequent. Ever since, principles have been laid down, and techniques have been improved. The framework of genetics was constructed by 19th century scientists and up to now—especially with the contributions from chemistry and biology—we have learned a great deal about seeds. However, as great as this knowledge may be, it is still insufficient.

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Figure 1 presents a simplified scheme of a plant's seed. All components are unique and necessary for the job the seed has been genetically tasked with [2]. The two main units of any seed are the germ and the adjacent food storage component—generally the endosperm—responsible for feeding the new plantlet during the initial phase of growth until the beginning of its own autotrophic food supply. This system seems to be quite simple, but its implementation is slightly more complicated. The germ possesses two major units: the initial tissues that will develop into the aboveground parts of the future plant (the plumule) and the opposite organ serving the initial growth of the root system (the radicle). The two units are bound together and driven by environmental tropisms, and they are connected to the food store by vital tissue, namely, the scutellum. This organ serves as an interface between the sprout and the endosperm during the first phases of growth and development. Finally, the entirety of this system is wrapped within a protective coating: the pericarp. The inner side of the pericarp houses a specific layer, the aleurone, that stores all the necessary enzymes, vitamins, and other compounds that are vital in the process of food supply [3]. All these components listed above signify the vulnerability of a seed. The level of this vulnerability is rather variable and distinct from the biological role of the very component that is so greatly influenced by the nature and magnitude of invasive stress. Therefore, it is worth furthering knowledge in this field.

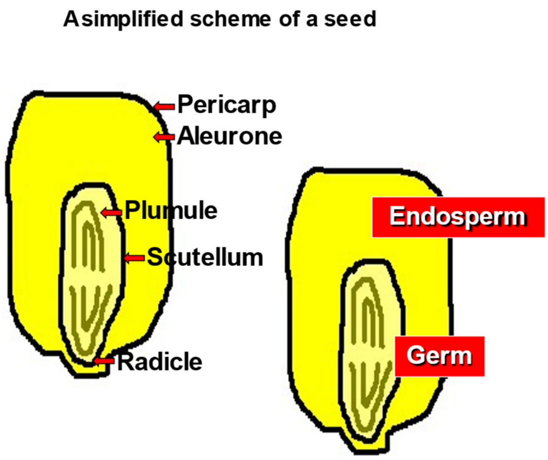

Figure 1. Simplyfied scheme of a seed.

The other assessment track concerns the functional nature of the seed, i.e., the determination of how it works. The first element of this range is viability. This physiological factor can be easily determined; however, the result is far from a yes/no answer. In agricultural terms, there is an empirical principle stating that the life of a plant starts with germination. If it germinates, it is alive. This is a straightforward principle, but it immediately generates many subsequent questions; for instance, when, how, and by what conditions does this process occur? The germination of any seed can start whenever the external conditions are favorable. Generally, there are three primary factors—temperature, moisture, and the presence of oxygen—that will allow the seed to begin this process. The magnitude of these factors varies according to the requirements of the plant species and is highly influenced by the environment/habitat in which it is located. In addition, there may be more external factors exceeding those essential three previously mentioned, including illumination, pH, or physical assistance such as scarification, and often the presence or absence of certain chemical compounds that may induce or inhibit physiological processes [4,5].

Whatever the case, germination begins with the development of the initial organs—the plumule and radicle—in a conventional way by plant cell multiplication. The availability of energy profoundly influences this process. This energy is typically provided by the food store of the seed, the endosperm, through the conversion of its starch molecules into more mobile sugars. This biochemical process is driven and controlled by plant hormones and the enzymatic armory of the seed. Thus, we have now arrived at the first crucial point of germination. All necessary factors and necessary input materials are present; however, germination will still not begin or will begin only poorly. There are two reasons for this phenomenon for which, until only recently, we had insufficient knowledge. The first reason is a cell- or tissue-level problem, namely, the failure of the scutellum, i.e., the interface between supply and demand. This problem can be caused by various morphological, physical, chemical, and/or other factors. The second problem occurs when the process has begun and all resources are available but the building materials for the newly born plantlet are deficient or uneven in their composition. In this case, the food store of the seed may be responsible for this problem, wherein the presence and availability of protein substances are less favorable in amount or in ratio. Cotyledons possess a wide range of proteinous compounds, among which gluten represents the group of non-water-soluble proteins: albumins, globulins, gliadins, and glutenins. In most agricultural crops, especially grain crops, this group represents the majority of proteins in the endosperm. Of course, many other proteinous compounds exist, such as peptides and polypeptides, free amino acids, and others. All these materials are dedicated to supplying building materials for the growth and development of seedlings [6,7].

Lastly, we must consider a seed's specific behavior with respect to its taxonomic origin. Such considerations include the length and duration of dormancy; vernalization; the response to external impacts such as allelopathy or simply the response to stimuli; various tropisms, including geo-, hydro-, photo-, thermo-, chemo-, and haptotropisms; and others.

Anthropogenic influences affect agronomy, phytosanitary conditions, harvest processes, postharvest handling, and storage. Seed treatments aim to maintain and preserve plant health and improve germination ability by adding external substances to the seed or exposing it to alien impacts such as irradiation and other stresses.

Seed production is an agronomic technology that is organized and controlled, at least to some extent, in most countries. Seed production is a complex process that operates within the framework of legal measures granted and implemented on national and international levels to secure quality and quantity. Therefore, the first step in seed production is the purchase of the initial seed from a legally secure source. Any seed and/or propagation material must meet two requirements. One is the proof of origin, wherein the seed item must be legally certified for use as attested by an authority [4]. The other is genetic purity and agronomic quality, which are proven by seed standards. These two requirements are applied in conjunction during the seed certification processes. There are various seed classes, such as breeder, foundation, registered, certified, commercial, and variety undeclared seeds. Seeds of the first two classes are used for further propagation, wherein marketable seed items or specific propagation items, such as parental line seed for hybrid plants, are produced. Seeds belonging to the remaining classes are used in various commercial production activities [3].

In most cases, seeds of unknown origin present a risk to society. They may be subject to illegal activities such as stealing, tampering, smuggling, royalty and tax avoidance, etc. However, the more crucial problems include the spread of pests and diseases as well as the deterioration of genetic properties via the continued overproduction of seed propagation grades, resulting in yield decline. Moreover, using such seeds may increase susceptibility to certain phytosanitary phenomena often inducing food safety and security problems or famine.

Once these concerns have been addressed, agronomic work can begin as usual; however, seed propagation will require many different skills compared to commercial crop production. We can roughly divide the seed production processes into two phases: field operations and postharvest handling and manipulation. In most countries, seed inspection follows the same routine. The reason for this is quite simple and can be explained as follows. There are many factors of plant production wherein the life of plants is monitored from sowing until harvest, thereby enabling us to follow and control all phenomena related to growth and development and providing us with a chance to intervene if necessary. The targeted areas of field inspection are as follows: crop site information on preceding crops, isolation, and past and present nutritional and phytosanitary data; growth and development patterns; a variety's identity and purity; the presence of noxious weed populations; and the occurrence of pests and diseases that may influence the expected seed quality. The most critical data are often the estimation or prediction of seed yield. All these parameters can be recorded from merely a handful of seeds during postharvest phases.

The sowing, planting, growing, and raising of a plant generation must be accurately performed. In most cases, apart from general crop production problems, securing their genetic properties is the largest challenge. The maintenance of genetic purity requires peculiar treatments. Inspection, selection, fertilization, synchronization, discarding, the removal of pollinators, castration, etc., are all tasks that highly influence the success of seed production. Furthermore, there is the final field operation: the harvest. Ripening, shattering, mixing, transportation, cleaning, drying, grading, storage, etc., are crucial aspects of this process.

After completing these tasks, we arrive at the second phase of seed production: the seed preparation and certification processes. Now we have the seed, but we still know very little about the seed itself. Therefore, we must perform further examinations and selections during this phase. The most essential data we record include viability determined by germination or physiological reagent tests and the physical parameters of the seed, such as the test weight, thousand-kernel weight, and size (often shape). In general, vigor test results are optional, but they are required in specific cases, such as cold tests or when handling other data that provide agriculturists with information on the future performance of a seed lot. Additional information can be recorded regarding moisture content, physiological conditions, health, and the presence of contaminants or alien matter whenever applicable. Finally, seed treatments must be applied and recorded in accordance with the crop species and variety. When these conditions are met, seeds may be certified and ready for further use [4].

Clearly, seed production and propagation are rather specific slices of agriculture. However, these processes form the basis of all our activities and are the means for their results. Namely, any slice of bread we eat is produced from grain yielded by a plant sown by healthy, productive, genetically desired, planned, cared for, and so-produced seed.

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