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Seed Dormancy in Groundnut - A Review

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Abstract: *Most Spanish and Valencia bunch varieties lack seed dormancy, whereas the semi-spreading and spreading varieties (Virginia types) have long dormancy periods. The non-dormant character of the Spanish and Valencia bunch varieties is a serious agricultural defect because considerable loss of yield results from in* situ *sprouting of nuts in the field if there is rain at the time of maturity. Sprouting of nuts also occurs in the stack in the threshing floor. It has been reported (Ramanathan, 1987) that 20-25% yield loss occurs due to in* situ *germination in bunch varieties. The in* situ *sprouting results not only in yield loss but also affects seed quality and storability.*

The yield losses due to viviparous germination can be avoidable if we have bunch varieties possessing a short period of dormancy (3-4 weeks). Introduction of seed dormancy by application of certain chemicals to the standing crop was found to be expensive and not so effective. Thus, the only practical solution to the problem is incorporation of seed dormancy into the Spanish and Valencia bunch varieties through genetic manipulation. Some Spanish bunch varieties have been found to possess seed dormancy of short periods, while most semi-spreading and spreading varieties (Virginia type) have dormancy of varying duration. Knowledge of the inheritance of seed dormancy and its association with other plant and pod/kernel characters will be useful for incorporating seed dormancy into Spanish and Valencia bunch varieties.

Key Words: *Dormancy, groundnut and seed*

INTRODUCTION

Out of the nine oilseed crops grown in India, groundnut accounts for 45% of the total area under oil seeds and 40% of the total oilseed production. Improved varieties play a pivotal role in increasing production and productivity of a crop. Considerable progress has been made in breeding varieties of groundnut possessing higher yield potential, higher oil content and disease resistance. Progress has also been made in evolving better production technology. But little attention has been given to improvement of any sowing quality of groundnut seed. One important seed quality component is dormancy.

In the field of seed biology, dormancy is still one of the least understood phenomena. One possible cause of limited progress in dormancy research is the absence of an unambiguous and explicit definition of dormancy. Also, the fact that seed dormancy can only be measured by germination has often led to misinterpretation because of interference with processes that are related to germination. A number of general reviews have been published in recent years (Hilhorst and Karssen, 1992; Hilhorst, 1992; Bewley & Black, 1994), which discuss the above problem.

Seed dormancy: Definition

Seed dormancy is failure or delayed germination of mature and viable seed under conditions favourable for germination. In simplest term, it is non-germination or low germination of freshly harvested seeds.

Seed dormancy is a phenomenon in which mature and viable seeds fail to germinate under conditions favourable for germination. It is a state

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of arrested development or physiological activity of seed. It is an adaptive property which enables the seed to retain viability for prolonged period of time and allows the seed to survive in adverse climatic and seasonal conditions.

A definition of seed dormancy that follows some recent suggestions by Hilhorst & Karssen (1992) and Hilhorst (1995) is the absence of germination of an intact viable seed under germination favouring conditions within a specified time lapse, although other definitions are just as valid.

Seed dormancy has its merits and demerits from agricultural point of view. One of the advantages of dormancy is that it prevents pre-harvest sprouting of seeds in the standing crop when there is rain at maturity stage or when the crop lodges into water in the field. Seed dormancy can however be troublesome to farmers. A farmer wishing to use the seed harvested in one season for growing the crop in the following season cannot do so if the period of dormancy is long. Seed dormancy is also a problem for plant breeders going for advancing pedigree lines in off-season. Similarly, the seed analyst faces difficulty in determining germination potential of seed samples having dormancy.

Biochemical basis of seed dormancy

The majority of higher plant species produce seeds with fully developed embryos that do not germinate during the entire period on the mother plant and after dispersal. Thus germination is suppressed during development and a relatively persistent block to germination may be present in the mature seed. Both the developmental arrest of growth and primary dormancy have long been associated with presence of various growth inhibitors, promotors, enzymes and other chemicals in the seed.

Abscisic acid (ABA)

ABA has long been associated with dormancy mainly because the hormone could be detected in both developing and mature seeds and it inhibits germination when applied exogenously. The availability of ABA-deficient and ABA-responsive mutants in a number of species has made a major contribution to the notion that absence of or sensitivity to ABA during seed development results in formation of non-dormant seeds (Hilhorst & Karssen, 1992; Hilhorst, 1995).There are reports on the presence of ABA in the dormant seeds of groundnut (Sharma *et al.* 1987).

Cytokinin and Ethylene

It is well established that the hormonal control of seed dormancy and germination involves a balance between inhibitory and stimulatory compounds in the seed (Khan, 1977). Although endogenous GAs are the primary promoters of germination, other hormones like cyktokinins and ethylene are also reported to be associated with regulation of dormancy and germination of seed. Several studies on the effect of exogenous application of these compounds have indicated the number of ways in which they could be involved in the germination process. Recent reports on involvement of these compounds in regulation of seed dormancy in groundnut (Whitehead & Nelson, 1992).

Phenolics

Phenolic compounds may inhibit seed germination and cause dormancy by inhibiting cell elongation or they may deprive the embryo of oxygen because of consumption of oxygen for their oxidation (Bewly & Black, 1994). Sengupta (1989) reported that dormancy in groundnut seed was positively related to phenol content and that seed germination in non-dormant cultivars appeared to be due to faster release of these chemicals from the seed by leaching.

Enzymes

Sengupta and Manglik (1987) reported differential activity of glutamate dehydrogenase and oxaloacetate transaminase, and Huang *et al.*, (1993) reported differential activity of benzoyl-arginine-p-nitroanilidase and gelatin hydrolytic enzyme in dormant and non-dormant seeds of groundnut. The activity of these enzymes is lower in dormant seeds and higher in non-dormant seeds.

Other chemicals

Several other chemicals than hormones, enzymes and phenolics have been reported to be associated with control and release of seed dormancy in various plants. Sharma *et al.* (1987) observed differential changes in total fat content of non-dormant (cv. J.11) and dormant (cv. M.13) seeds of groundnut during imbibitions. The total fat content of fresh non-dormant seeds of J.11 decreased with time during imbibitions, while little changes occurred in fresh dormant seeds of M.13. A period of dry storage overcame seed dormancy and increased the rate of lipid depletion.

Measurement of seed dormancy

Seed dormancy is measured in terms of duration or period of dormancy and intensity of dormancy. There is, however, no agreed method for measuring either the duration or the intensity of dormancy. Pandya and Patel (1986) and Varman and Arjuna (1990) estimated dormancy period in groundnut as the number of days taken from harvest to achieve germination percent equal to the minimum certification standard (70%) for the crop, whereas Kumar *et al.* (1991) estimated dormancy period in groundnut as number of days taken from harvest to achieve 50% germination. The problem of measuring dormancy intensity is same as with measuring period of dormancy. There is no clear cut method for measuring the intensity of dormancy. Thus, different workers have used different methods for estimating this parameter of dormancy. Kumar *et al*. (1991) estimated dormancy intensity in groundnut as per cent non-germinated seeds at 7 days after harvest.

Seed dormancy in groundnut

Studies by several workers indicated that seeds of Spanish and Valencia bunch types are usually non-dormant, whereas those of Virginia types are dormant (John *et al*., 1948; Pandya & Patel, 1986; Patil & Bhapkar, 1987; Sharma, 1987; Gowda *et al*., 1989; Kumar *et al*., 1991; Varman & Raveendran, 1994). In an earlier study, however, Varman and Raveendran (1991) observed a dormancy period of 18 days in a bunch type cultivar.

Reddy (1982) reported dormancy periods of 40-77 days in a study with 11 semi-spreading and 14 spreading type cultivars. Kapur *et al.* (1990) observed dormancy periods of 63-84 days in four spreading type cultivars. Abrar and Jadhav (1991) observed dormancy period of less than 20 days in 15 and 20-40 days in 7 bunch varieties, and 45 and 46 days in two semi-spreading cultivars.In a study of the dormancy behaviour of Spanish bunch, Virginia bunch and Virginia runner types, Keneni *et al*. (1993) observed dormancy periods up to 2 months in Virginia type cultivars (NC 343 & Shulamith), while the Spanish type showed no dormancy.

Nagarajan and Gopal Krishnan (1958) reported that the non-dormant nature of the bunch varieties was due to the presence of a water soluble auxin like substance in the seeds. Aqueous extract from seeds of bunch varieties was found to break the dormancy of spreading varieties. Ketring (1973) suggested that dormant groundnut seeds had ABA-like substances.

Sreeramulu and Rao (1968, 1971) observed continuous increase of some phenolic acids and phenolic compounds during seed development in dormant varieties of groundnut.

Sengupta *et al.* (1979) reported that dormancy period of spreading varieties was due primarily to presence of growth inhibitors in the embryo and partly due to seed coat factor. Sengupta (1989) did not find any relationship of seed dormancy with phenol content of seed in groundnut. He noted that seed germination in non-dormant cultivars appeared to be due to faster release of phenols from the seeds by leaching.

Lack of seed dormancy in most Spanish and Valencia bunch cultivars is a factor affecting groundnut production in areas receiving pre-monsoon showers. Yield losses ranging from 20 to 50% due to *in situ* germination have been reported by several workers (Reddy, 1982; Nagarjun & Radder, 1983; Ramanathan 1987; Varman & Raveendran, 1991). A solution to this problem lies in incorporation of a short period of dormancy into the regionally adapted cultivars of the Spanish and Valencia groups.

Reddy *et. al*. (1985) developed a dormant Spanish bunch cultivar 'CGS 1-19' from the cross J.11 x Robut 33-1, which is now under cultivation. Manoharan *et al.* (1994) selected 16 dormant bunch genotypes from crosses of non-dormant Spanish bunch types with Robut 33-1 and TG 19A having dormancy periods of 35 & 20 days, respectively. The selected bunch genotypes possessed short period of dormancy.

Genetics of seed dormancy

Pre harvest sprouting in groundnut seeds belonging to sub-species fastigiata Ghana is undesirable since it leads to substantial loss of seeds, both in quantity and quality. It was also reported that seed dormancy is controlled by monogenic inheritance with dominant over non-dormant. (Asibuo James Yaw *et. al.*, 2008)

Stokes and Hull (1930) reported that dormancy in groundnut was incompletely dominant over non-dormancy. Hull (1937) reported a multigenic control of dormancy in groundnut, whereas Lin and Lin (1971) reported that it was controlled by a single dominant gene.

Association of seed dormancy with other characters

Seven peanut genotypes tested both under field and laboratory conditions at senegat exhibited different intensity (12-100%) and duration (7-35 days) of fresh seed dormancy. It was also noted that there was strong similarity between the results from the field test and laboratory tests. Therefore one could use an in vitro assay to reliably assess the level of dormancy on peanut lines (Faye, 2009).

Kapur *et al*. (1990) reported positive correlation between seed dormancy and maturity duration in groundnut. In a study of several accessions of Chinese dragon groundnut, Jiang *et al*.(1994) observed a positive association between intensity of seed dormancy and drought tolerance of the genotypes.

Environmental effect on seed dormancy

Seed dormancy, though genetically controlled, is greatly influenced by the environmental conditions under which development takes place. There are many reports on the effect of growing season, temperature, solar radiation, RH rainfall, soil fertility, soil moisture etc. on the intensity and duration of seeds dormancy in various species. Some of the recent reports on this aspect and reviewed in the following paragraphs.

Growing season

Seasonal variation of seed dormancy has been observed in a number of plants. Zode *et al.* (1994) in their studies on breaking dormancy in 4 groundnut cultivars grown in 2 seasons, reported that the seeds of cv. UF 70-103 produced in *kharif* responded to ethylene treatment 8 days after harvest, while those produced in summer took 18 days.

Rainfall and RH

It is well established that high rainfall during seed development reduced seed dormancy, presumably due to leaching out of inhibitors from the seed. Several workers have reported negative correlation of seed dormancy with rainfall.

Methods of breaking seed dormancy

In natural conditions, one or more of the factors such as light, temperature, ageing etc. may operate to convert a seed from dormant to germinable state. Under laboratory conditions, several other physical and chemical treatments have been found to break seed dormancy. Some of these are likely to be of importance in nature and may help to understand the possible mechanisms involved in the maintenance and release of seed dormancy (Bewley & Black, 1994).

High temperature

High temperature treatment (dry heating) has been found to be effective for breaking both seed coat-imposed and embryo dormancy.

Kapur *et al.* (1990) reported that heat treatment of dry pods at 500C for 96 hr was effective for breaking seed dormancy in groundnut.

Alternating temperature

The effect of alternating temperatures on imbibed seeds has since been observed in many other species. Some of the recent report as to the effectiveness of this method for breaking dormancy include those of Kapur *et al.* (1990) in groundnut.

Washing

Washing dormant seeds by water was been reported to break dormancy probably due to leaching of the dormancy factor from the seeds. Soaking of seeds in distilled water was found partially effective in groundnut. (Kapur *et al.*, 1990)

Chemical treatment

Many different chemicals have been found to break dormancy and accelerate germination. Seeds of many species respond to these substances which include growth regulators, respiratory inhibitors, nitrogenous compounds, oxidants etc.

Gibberellins

Treatment with gibberellins has been found to break dormancy and accelerate germination in several species. Effective concentrations lie within the range of 10-5 to 10-3 M. Application of gibberellins has been found to be effective for breaking seed dormancy in groundnut (Kapur *et al*., 1990; Abrar & Jadav, 1991).

Ethylene

Ethylene, supplied either directly as gas or by means of an ethylene generating chemical such as ethrel or ethephon, has been found to break dormancy in several species. The effective concentrations are in the range of 10-200 ppm. Recent reports on successful use of ethylene for breaking seed dormancy include those of Kapur et al., (1990), Varman & Raveendran (1994) and Zode *et al.* (1994) in groundnut.

Nitrogenous compounds

Nitrates and nitrites are known to break dormancy and stimulate germination in may species. Effectiveness of KNO3 for breaking seed dormancy has been reported by Kapur *et al*. (1990) in groundnut.

Alizaga *et al.* (1992) studied the effects of hydrogen cyanide (CH2N2), 6-benzyl- aminopurine (BA) and GA3, singly and in combinations for breaking seed dormancy in groundnut. A combination of BA (0.1-0.25%) and CH2N2 (1%) produced the best result.

Storability and dormancy of seed:

Strokes and Hull (1930) and Hull (1937) studied the effect of storage temperature on the dormancy behaviour of some Spanish and runner cultivars of groundnut and found that storage at 30C increased dormancy period and storage at 20-400C decreased it. Dormancy in Florida runner cultivars was overcome when the seeds were stored at 20-400C. They suggested that the rest requirement appeared to get decreased with increase in storage temperature.

Echandi and Villalobs (1989) studied the dormancy behaviour of seeds of groundnut cultivars under 4 storage conditions and found that in traditional storage (22.6-32.50C temperature & 54.5-98.2% RH), dormancy was brokern after 56 days, while in cold (0.50C & 45% RH) and air-conditioned (150C & 72% RH) storage, it took 120 days for dormancy to be dissipated.

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