EFFECT OF SOME CHEMICAL AND PHYSICAL MUTAGENS ON VICIA FABA

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I. INTRODUCTION

Nowadays, the interest in applying induced mutations in plant improvement programmes has markedly increased.

Through preliminary research, it had to be established which is the most efficient way to obtain more economic mutations. Irradiation (x, γ, neutrons) may produce mutation spectra and mutation frequencies which are different from those induced by chemical mutagens. Heslot (1959), found in barley that the mutation frequency as expressed by the percentage of ears segregating for chlorophyll mutants, could be 5% in the case of γ-rays (25 kr) and up to 50% with EMS. Dommergues (1962), after treatment of barley with γ-rays obtained 1% mutants, in the case of EMS it was 14%. Bremer-Renders (1964) stated that the spectra of the chlorophyll mutants following treatments with chemical mutagens had more than common types, while the x-rays induced spectrum had more of the rarer types. Also, similar results were recorded by Amin and Bianu (1970), and others.

The nature of irradiation may have its influence on the occurrence of mutations. Blixt (1963) found in peas that after treatment with x-rays, 65% of the total number of mutations were chlorophyll mutations, while it amounted to 75% in the case of neutrons. Also, the concentration of the chemical solution and the dosage in the case of irradiation

He stated that the M_1-injury was very clear at doses higher than 5 kr. Moreover, he showed that LD_{50} for survival was dose of 15 kr.

Gladstons (1958) found that a dose ranging from 50 to 60 kr. from x-rays was necessary to produce any reduction at all, in percent of survival at maturity in Lupinus.

Gilles and Dee Winck (1959) studied the effect of x-rays on peanut seeds, previously immersed in water for 48 hours. They found that the LD_{50} for survival lays between 2 and 5 kr. At higher dosages abnormalities of various kinds became frequent. Complete lethality was found between 20 and 25 kr.

Favret (1963 and 1965) studied the effects of x-ray and γ-ray seed treatments, on the M_1-plants of barley. He stated that seedling growth was affected by x-rays or γ-rays and produced a linear response.

Heringa (1964) found that the percentages of germination in Poa at M_1 generation was only slightly reduced when dry seeds of the variety Pouli were subjected to irradiation with x-ray, gamma-ray and neutrons.

Radiation experiments in Poa pratensis (Gustafsson and Gadd, 1965) revealed that increasing x-ray dosage resulted in a clear reduction in germination percentage as well as survival rate. The authors treated dry dormant seeds by x-ray doses from 12.5 to 30 kr. Also, they found that an LD_{50} for germination (on filter paper) was about 27 kr, while for survival (after transplantation into the soil) was of about 17 kr.

Gregory (1966) reviewed the work made on peanuts, and stated that since peanuts have a relatively direct effect of irradiation in X_1 generation are readily observable. Dose-response data in peanuts resemble those obtained for seedling of other plants. Measured in terms of height of the main axis number of expanded leaves and survival percentage on a 23-days old X_1-plants, the three characters showed reduction of similar patterns. In all cases, increasing the radiation dose caused an increasing reduction in the performance of the characters. However, the data showed that the doses 2.5 and 5 kr. caused a relatively very slight damage in X_1-generation, while the doses 10 and 20 kr caused a high degree of X_1-damage.

Snaidersa and Kalvart (1968) showed that, ^{60}Co γ-irradiation of germinating seeds of Vicia faba at various doses

2,000, 6,000 or 12,000 r suppressed seedling development, the suppression being directly proportional to the strength of the doses applied. Splitting the irradiation into 3 doses increased its effect at all levels.

Uprety (1968) showed that, there was a significant increase in germination and survival percentage, from seed irradiated of <u>Vigna unguiclata</u> L. with 4 kr. of γ-rays; irradiation accelerated flower initiation by 8 days. Higher doses of irradiation adversely affected these characters; 2 kr. did not affect them.

Vlk and Jancovec (1969) stated that exposure of seeds of <u>Vicia faba</u> c.v. Lehmanns Weenders to 0.5 - 11 kr gamma radiation for 6, 12 or 24 h decreased seedling emergence. Increase in dosage from 3 to 11 kr increased seedling damage. Irradiation, especially for [illegible] h, damaged the apical meristem, but stimulate lateral branch growth. Significantly lethal doses were 5 kr and 7-9 kr with 6 and 12 to 24 h exposure, respectively.

Studying the effects of γ-rays on M_1-seeds germination and seedling height injury in rice, Woo and Pye (1971) found that γ-rays gave significant damage to seedling growth, however, seed germination was slightly affected.

In literature, it is frequently stated that different varieties of the same species respond differently to the mutagen.

Bilquez and Martin (1961) gave a series of x-ray doses ranging from 8 to 40 kr to dry seeds of two peanut varieties. One of them (Viz. 28204) showed high survival rate, even after the application of the highest doses (decrease in germination no more than 12%). The other variety (Viz, 45115) gave an LD_{50} value for germination at a dose of 32 kr. In the later variety only, the lowest dose seemed to stimulate germination. Paralleled this, the number of surviving plants until flowering decreased more in Var. 45115 than in Var. 28204. Moreover, they concluded that this previous relationship is the characteristic of that between dose and radiation induced chromosome breaking. The seedling indicated comparable varietal differences in sensitivity to damage induced by this mutagen as observed for x-rays. They concluded that genotype and radiation dose are the most important factors influencing radiation sensitivity.

Gustafsson and Gadd (1965) reported similar varietal differences in x-ray sensitivity in Poa pratensis. They found that the LD_{50} differed according to the variety. For dry seeds the LD_{50} was between 10 and 35 kr x-rays.

Jaranowski and Luozkiewicz (1966) showed that the seeds of seven different lines selected from crosses of species and varieties of Pisum, and six-lines selected from Vicia sativa, responded differently to -radiation treatment.

Blixt (1967) studied the differences in radiosensitivity, in two radiation experiments comparing 34 different genotypes of Pisum sativum. He concluded that as regards γ-irradiations, germination and seedling growth had a clear difference in response between different lines. Consequently, he tentatively suggested that the differences in reaction were taken as an indication of the genetic mechanism underlying the M_1-damage in the sense of germination and growth reduction and was influenced at least partly by the specific allelic combination.

Goud et al. (1967) compared six varieties of paddy rice (Oryza sativa) after irradiation of the seeds with different doses of -ray. Increase in dosage delayed germination in all the varieties except Taichung Native 1, seedling height was measured the ninth day in all treatments. In a control experiment, S_{705}, S_{2222} and Taichung Native 1 were taller than Tainan 3, Taichung 65 and IR8 varieties. The coefficient of variation was increased at 20 kr (at 50% growth inhibition) in all the varieties except Taichung Native 1, which appeared to be more resistant to irradiation.

Sanjeeviah et al. (1967) found that, γ-rays decreased germination percentage, of groundnut cv. HG-8.

Blixt (1969) extended his study to include sixty-two different genotypes of Pisum sativum, irradiated with X-rays. Using the same criteria (germination and growth inhibition) for measuring the effects in M_1-generation. The study revealed differences in radiosensitivity between different genotypes. However he identified one gene, designated "A" exerting a major effect on X-ray sensitivity.

[illegible] and Gheorghita (1967) found that, when dry seeds of 2 soybean cv. were treated with 2,5, 8, 12 or [illegible] kr γ-radiation from a ^{60}Co source. The LD_{50} for growth was between 5 and 8 kr for both varieties, but Chippewa was somewhat more sensitive than Merit te.

Pak[illegible]dorf (1970) studied the results of the irradiation of dry seeds of Lupinus L, at doses up to 100 kr. He [illegible]ated that only L. angustifolius and L. albus could tolerate dose in excess of 100 kr., L. angustifolius being the more resistant species. From the plant survival rate at 60 days in these two species and at 30-40 days in L. mutabilis and L. luteus the number of plant reaching the flowering capacity of L. angustifolius and L. albus was stimulated with 5-20 kr.

Boreyko (1971) studied the effect of x-rays and γ-rays on the M_1 germinating rate and survival of 16 different varieties of soybean. A specific reaction of different varieties to some doses of the mutagen used, and different action of mutagen factors (mutagen dose) on the same variety were shown. Consequently, an assumption was introduced by him on genetic control of the specific reaction of the varieties to the effect of mutagen.

Medvedev et al. (1972) showed that, in 12 to 15 day-old seedlings of V. faba irradiated with ionizing rays at a dose of 2. kr, 3 growth inhibitor fractions were detected 24 h after irradiation which markedly increased the contents of 2 of them. It was shown that the 3 growth-inhibitor fractions can act synergistically.

b. Growth characters:

Popovic et al. (1966) indicated that the irradiation of dry seed of four barley varieties with various doses of γ-ray produced reductions in the M_1 in the percentage of germination, tillering capacity, plant height, ear length and proportion of fertile flowers per ear.

Woodstock and Justice (1967) exposed seeds of corn, wheat, sorghum and radish to 0, 5, 20 and 80 K-rad doses of γ-ray from Co^{60} source. Doses 80 K-rad caused marked inhibition in seedling growth and did not inhibit respiration. Five K-rad caused slight but consistent stimulation in seedling growth.

Bader (1968) stated that gamma radiation increased the number of branches per plant in the pea variety Little Marvel. Nevertheless, he reported that the increase in the number of branches was not linear with the increase in the level of the given dose.

[illegible] (1969) showed that the relatively low doses of gamma radiation (1 and 3 kr) increased the number of branches per plant in *Vicia faba* L. whereas higher doses (5 and 10 kr) reduced the number of branches per plant.

Mostafa *et al*. (1969), after treatment of seeds of field bean cv. [illegible] 1 with 1, 3, 5 or 10 kr γ-radiation and stored at room temperature or at 10 °C for 6-12 weeks before sowing in the field, found that percentage of emergence, period to flowering, height of mature plants, numbers of branches and pods, seed yield and 100-seed weight increased with storage for 2-4 weeks and then decreased again. Low temperature storage reduced the amount of damage sustained.

El-Gibali (1971) revealed in pea treated with gamma radiation that the number of branches showed insignificant differences among treatments.

c. Yield and its components:

Rawlings et al. (1958) indicated that x-ray doses from 7 kr - 20 kr and thermal neutron doses at 5.6×10^{12} N^{th}/cm^2, and 2.4×10^{13} N^{th}/cm^2 significantly increased the seed weight in the soybean.

After dormant seed irradiation of six wheat varieties belonging to three botanical species) with ^{60}Co γ-rays in doses 5, 10, 20 and 30 kr., Mohamed et al. (1964) reported that some characters such as number of tillers, number of ears per plant, ear length, number of spikelets per ear and grain weight, were not influenced by radiation, while others i.e plant height, number of grains per ear, seed set per spikelet and grain yield per plant were decreased, and heading period and stem rust infection were increased.