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Effect of Hydroxylamine on the Germination and Growth of Sesame (*Sesamum indicum*)

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Abstract: *Sesamum indicum* is a plant of repute, nutritionally and medicinally worldwide. In an effort to improve the cultivation of local cultivar of this plant, the effect of hydroxylamine (HA) on its seed germination, vegetative and yield components were investigated. Germination was found to be influenced significantly by soaking the seeds in varied concentrations of HA. The untreated seeds were used as a control. The germination percentage was found to be dose dependent. Plant height increased at low concentration and decreases by increasing HA concentration in M_1. The number of leaves were markedly influenced by HA treatment and 0.09% was found to be optimum for leaves production in this study. The pattern of growth in the M_2 generation appears to be retrogressive as the level of variation was found to be insignificant except in the numbers of leaves and capsules. Treating the seeds of *S. indicum* with hydroxylamine increased the germination and seedling development. None of the treatment induces chlorophyll deficient mutants.

Key words: *Sesamum indicum*, hydroxylamine, germination, seedlings, growth, mutation

Introduction

The improvement of crop plants depends to a large extent on genetic variability within the species. Ancient plant breeders resorted to the genetic variants provided by nature and select species with the desirable traits. Over the years, man relied upon spontaneously occurring variants, coming from mutations, to improve the yield and quality of crop plants (Herper, 1999). In the first two decades of the 20th century, ionizing radiations and chemical substances were used to effectively induce mutations in plants (Poehlman, 1979). The use of chemical mutagens in crop improvement has been reported in a number of species (Ojomo and Chheda, 1972; Sander and Muchlbever, 1977; Biswas and Datta, 1988). The use of hydroxylamine to induce mutants has been reported by a number of workers (Verma and Ling, 1978; Boreiko *et al*., 1988; Chow and Loo, 1988; Mahna and Gupta, 1989; Mensah *et al*., 1990; FAO/IAEA., 2002). There is however, no report in the literature on the effect of hydroxylamine on the growth of sesame cultivars in Sokoto-Nigeria. Yet, such information is vital in understanding its physiological and growth behaviour.

Sesame (*Sesamum indicum* L.) is one of the most important oilseed crops in the world according to some archaeological findings (Nayar, 1984; Bedigian and Harlan, 1986). It is an erect, branched, annual plant that grows up to a height of 3 m. The flowers are self-pollinating and the capsules are borne on the length of the stem either singly or in pairs. The seeds of *Sesamum indicum* are rich in protein, fat, calcium, phosphorus and a fair source of B vitamins, substantial amounts of trace elements and fatty acids (FAO, 1988). Sesame is used in folk medication for the treatment of piles, coughs and to stimulate lactation and menstrual flow, as an aphrodisiac and as a soothing dressing for burns (Brouk, 1975; Weiss, 1983). It is a drought resistant crop that is sensitive to excessive rain and water logging (Dutta, 1979) and well suited to different crop rotations and is mostly grown under moisture stress with low management inputs by small holders (Ashri and van Zanten, 1994). The production of *Sesamum indicum* is restricted of areas that are not agriculturally mechanized (Ruttan *et al.*, 1974). In Nigeria, sesame production is restricted to Kwara, Benue, Gongola and Niger State (Agboola, 1979; Adekunle, 1989).

S. indicum is generally unimproved and many collections have been made of land races, with little or no genetic information that can lead to its utilization in breeding programme. A number of factors affecting sesame improvement programmes have been identified. Firstly, the germplasm of sesame is not as large as in other crops (Ashri, 1982). Secondly, the architecture of sesame is poorly adapted to modern farming systems because of its indeterminate growth habit, sensitivity to wilting under intensive management and seed shattering at maturity (Cağirgan, 1994, 2001; Uzun and Çağirgan, 2006). In recent times, a number of mutant lines have been produced worldwide through mutagenesis. This study aimed at investigating the effect of hydroxylamine on germination and growth of sesame as a strategy in its improvement programme.

Materials and Methods

The study was conducted in 2002/2003 at the Department of Biological Sciences garden of the Usmanu Danfodiyo University, Sokoto-Nigeria which lies between longitudes 4°8'E and 6°54'E and latitudes 12°'N and 13°58'N. The capsules of *Sesamum indicum* cultivar were obtained from the research farm of the University, seeds were dehisced and stored in paper bags at room temperature and hydroxylamine (M and B, UK) was obtained from a chemical store in Zaria-Nigeria. The five concentrations of hydroxylamine prepared and selected for this experiment were 0.01, 0.03, 0.06, 0.09 and 0.12% respectively.

To ensure that the seeds used for the experiment were viable and of high quality, the sample lot was subjected to viability test using the tetrazolium technique (Grabe, 1970). The seeds were imbibed for 24 h in water, cut along the margin without damaging the embryo and soaked in colourless 0.1% solution of 2,3,5-triphenyltetrazolium chloride (TTC) solution for 16 h at 25°C in the dark. The seeds were then removed from TTC solution, washed with distilled water and soaked in 10 mL of 95% ethyl alcohol to permit direct observation of the embryo. The embryos of viable seeds appeared reddish in colour. Three replicates of 100 seeds each were examined.

Seeds were soaked in respective concentrations and another set in distilled water to serve as control. After 12 h of chemical treatment, all seeds were leached with distilled water before the experiment. Germination trials were conducted in 9 cm sterile petri dishes lined with two Whatman No. 1 filter papers and moistened with sterile distilled water to ensure adequate moisture for the seeds. The experiment was laid out in split plot design and replicated thrice in the laboratory. The seeds were examined daily and considered germinated when the radicle was visible.

Growth studies of the seedlings were conducted in a greenhouse of the Usmanu Danfodiyo University Sokoto-Nigeria, Biological Sciences. Seeds soaked in respective concentrations of hydroxylamine were used for the evaluation of seedlings traits. Nursery was initially raised and seedlings at four leaf stage were transplanted in plastic pots measured 19 and 20 cm for height and diameter, respectively. The experiment was a completely randomized design replicated thrice. The seedling traits were evaluated bimonthly to flowering. At harvest, seeds were bulked (M_1) and planted to get M_2 generation. The vegetative and yield parameters of the M_2 lines were evaluated at flowering and at harvest. At the end of the trials, the data were analyzed using MSTAT-C statistical package. The treatment means that showed significant difference were compared using LSD at 5% probability.

Results and Discussion

Result of germination study shows that germination increased with concentration of hydroxylamine (Fig. 1). There were significant differences in germination percentage among the

Table 1: Vegetative and yield parameters sesame M_2 evaluated at harvest

Concentration (%)	Plant height (cm)	No. of leaves	No. of capsules	Days to flowering
0	86.83±0.53	66.00±3.05^{c}	44.30±3.05^{ac}	87.60±1.20
0.01	97.36±1.19	53.00±2.77^{a}	52.60±2.77^{c}	79.50±0.50
0.03	100.30±1.65	75.00±1.53^{b}	74.50±1.53^{b}	75.50±2.05
0.06	79.81±7.50	73.00±2.00^{b}	73.10±2.00^{b}	65.80±9.30
0.09	90.85±0.56	72.00±3.21^{bc}	72.10±3.21^{b}	70.50±5.05
0.12	83.60±1.50	35.00±2.10^{a}	37.00±2.51^{a}	77.00±1.50

Means within each column of a treatment followed by the same superscript are not significantly different at $p<0.05$ as determined by LSD

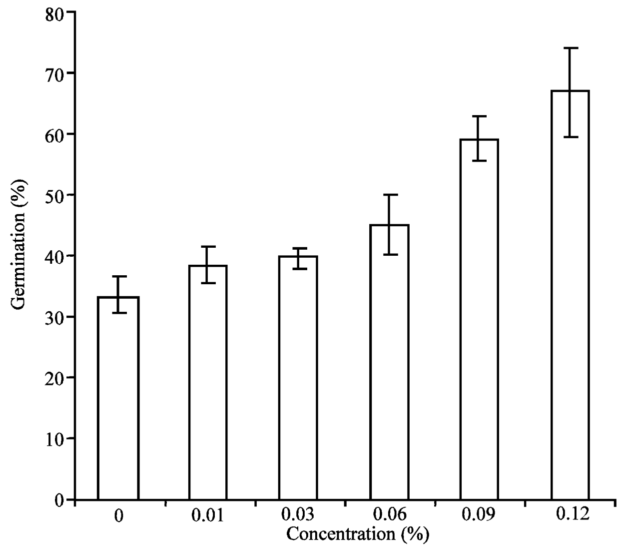

Fig. 1: Percentage germination in sesame as affected by hydroxylamine treatment

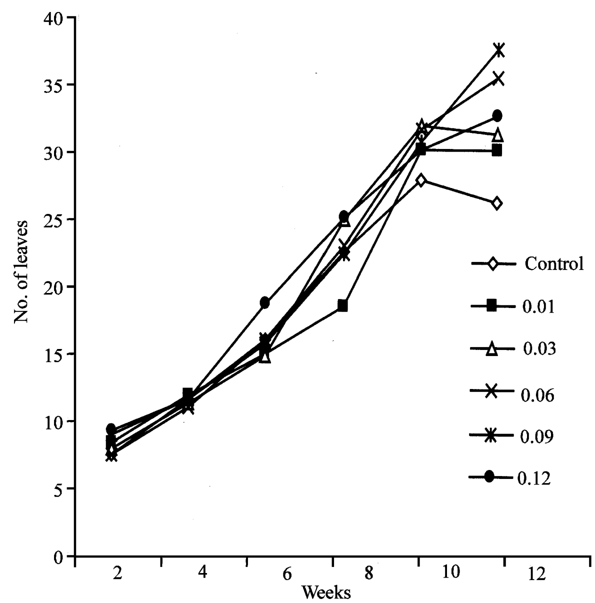

Fig. 2: Effect of hydroxylamine on the number of leaves in sesame M_1 generation

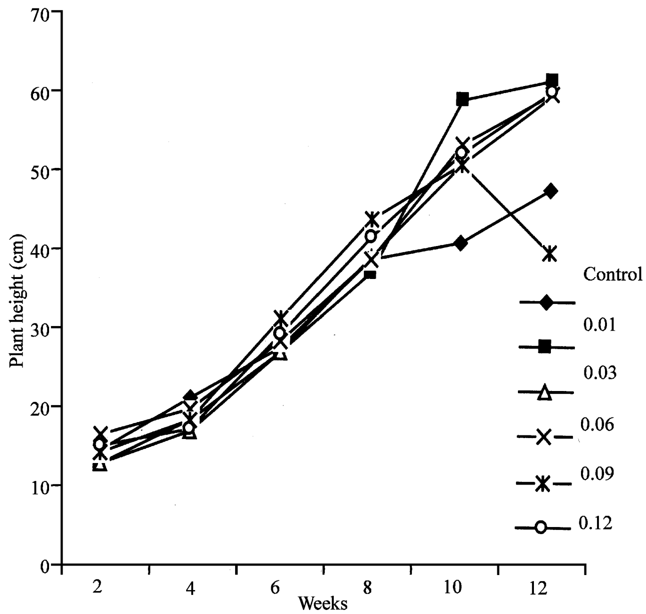

Fig. 3: Dynamics of plant height as affected by hydroxylamine in sesame M_1 generation

treatments at 5% probability. High germination percentage was obtained with 0.12% HA treated plant, while the control and 0.03% had the lowest. The effects of chemical substances on the percentage germination of seeds have been reported by Khan (1987), that chemical substances can penetrate the seeds and interact with the vital metabolism of the cell and hence, stimulate seeds germination.

The dynamics in the leaves number with varied concentrations of hydroxylamine (HA) over the experimental period are presented in Fig. 2. The number of leaves increased with the dose of HA and plants treated with 0.09% produce high number of leaves. The numbers of leaves were lower in the control and 0.01% treatment. In this study, the use of 0.09% is considered to be optimum for leaves production in this species. The ability of chemical mutagen to increase the number of leaves has been reported in *Trigonella foenumgraecum* using 0.25% of Ethyl methyl sulphonate treatment (Biswas and Datta, 1988). Shedding of leaves was observed in most of the plants except those under 0.06% HA treatment; this could probably be responsible for the decreased number of leaves observed in this study. This problem of leaves and flowers buds shedding has been reported in sesame at different stages of its development (Falusi and Salako, 1998).

The plant height was found to increase at low level and decreased at higher level of hydroxylamine treatment (Fig. 3). It is interesting to note that, plants treated with 0.09% produce plants that were shorter. The decrease in plant height is probably associated with the loss of vigour. A similar trend was observed by Mensah *et al.* (1990), where low dosage of hydroxylamine led to the increased plant height in *Vigna unguiculata*, while, higher dosage decreased plant height significantly. The inhibitory effects of mutagens on plant height have been reported (Selim *et al*., 1974; Verma and Ling, 1978). According to Uzun and Çağirgan (2006), reducing plant height could be a means of improving lodging resistance for sesame breeders when lodging is a problem.

The means and standard deviation for vegetative and yield parameters of M_2 generation evaluated are presented in Table 1. Most of the parameters evaluated was found to be insignificant ($p>0.05$). Generally, plants treated with varied concentration of HA were taller except in 0.12% treatment, which are comparatively shorter than control. Although, plant height was found to be different between the treatments, result from the analysis of variance indicated insignificant different at $p>0.05$. However, the values for the plant height are high in plants treated with 0.03% while, 0.12% had the lowest. A significant difference at $p \leq 0.05$ was found in the numbers of leaves and capsules per plants. The treatment with 0.03% produce high number of capsules and 0.12% had the least. The number of days to 50% flowering was insignificant. None of the treatments induces chlorophyll deficient mutants in this species.

In this study, seed treatment with HA increased the germination percentage significantly except in treatment with 0.03 and 0.06% which are not significantly differently from the control. The highest percentage germination was found in 0.12% treatment. Plants treated with 0.06-0.09% HA appear to be high yielding variants with increased in vegetative growth. Mutant variation could provide genes at previously unknown loci with similar phenotypic expressions in a better adapted genetic background (Gustafson and Lundavist, 1981; Vuayakumar *et al*., 1993). The use of mutants represents a complimentary method of modern plant improvement (Konzak *et al*., 1984; Sunta, 1995; Sah, 1995). The ability of hydroxylamine to induce changes in vegetative growth of this plant is a pointer for its possible exploitation in leaf production as the leaves are reported to be used as vegetable in some localities in Nigeria (Adekunle, 1989).

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