Effects of Selected Chemical Stimulants on Germination of Castor (*Ricinus Communis* L.) Seed

Msaakpa T. S[*], Obasi M. O[**]

[*] Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi, Nigeria.
[**] Department of Crop Production, University of Agriculture, Makurdi, Nigeria.

Abstract- A study was conducted at the Teaching and Research Farm of the University of Agriculture, Makurdi in 2007 and 2008 cropping seasons to monitor the effects of selected chemical stimulants on castor seed germination. Top paper (TP) method of seed germination according to Toogood (1993) was adopted. The chemical stimulants used included: 2, 4 – Dichlorophenoxyacetic acid (2, 4-D) **@** 200mg/L, coconut milk @ 15%, aluminum tetraflouride (AlF_4) @ 200mg/L, fusiccoccin (FC) @ 200mg/L, potassium nitrate (KNO_3) @ 15% and ethrel @ 200mg/L. The chemical stimulants were put into 9cm-diameter petridishes, each containing ten seeds of each castor accession. Data were collected on first germination count at 7 days after planting (DAP), final germination count at 14 DAP, pre-emergence mortality at 14 DAP, post-emergence mortality at 14 DAP, and germination speed index was used to quantify seed, seedling vigour and the planting value of seed lots. Results revealed that 15% of coconut milk followed by 15% of potassium nitrate and 200mg/L of aluminum tetraflouride produced significantly higher final germination count and germination speed index but lower seed mortality rate was observed with untreated seed lot (control) and with 1% of hydrogen peroxide. Germination characteristics were not significantly different in 2007 and 2008. Year x stimulant interaction on germination characteristics was not significant in all the castor accessions studied.

Index Terms- castor, chemical stimulants, seed germination.

I. INTRODUCTION

Castor (*Ricinus communis* L.) is an industrial crop grown for its economic seeds exploited mainly for producing castor oil (Uvah et al., 1991). In Nigeria, seed yield is low in the range of 500-650kg/ha. Thus, it contributes very little as a foreign exchange earner in Nigeria and its production is below optimum level for industrial uses. Castor plant has so far remained underexploited and little is known about its regular cultivation.

One major limitation to its large scale production throughout the world has been the problem of poor germination due to seed dormancy. According to Lago *et al* (1978) seed dormancy in castor is manifested in slow, erratic and low germination. Treatments like scarification and stratification are needed to overcome external and internal dormancy (Baskin and Baskin, 1998). Although the seed germination biology of many plant species has been investigated (Nikolaeva and Rasumova, 1985), there is paucity of information concerning that of castor.

Little work has been done on the aspects of the type, causes and control of dormancy in castor seeds. Studies on pre-sowing treatments to break dormancy in castor seeds have also not received desired attention. The problem of dormancy in castor seeds require systematic studies as to ensure uniform germination and to improve its planting value. There is also a dearth of information on the response of castor seeds to some chemical stimulants with respect to seed germination. The objective of this study was to determine the effects of some chemical stimulants (plant growth regulators) on castor seed germination.

II. MATERIALS AND METHODS

Seeds of *Ricinus communis* L. were collected from Premier Seeds Company in Makurdi, in 2007. Top paper (TP) method of seed germination according to Stafford and Metzer (1970) was adopted at Crop Science laboratory, University of Agriculture, Makurdi, to study the effects of chemical stimulants on castor seed germination in 2007 and 2008. Treatments used included, four castor accessions viz: LAF-4, LAF-11, AKW-5, AKW-7; and five chemical stimulants namely: 2, 4-D @ 200mg/L, Coconut milk @ 15%, Aluminum tetraflouride @ 200mg/L, Fusicoccin @ 200mg/L, and Ethrel @ 200mg/L. The chemical stimulants were put in different 9cm-diameter Petri-dishes, each containing ten seeds of each castor accession. The experiment was laid out in Completely Randomized Design replicated three times. Treatment effects were observed for 24 hours. Germination tests immediately followed treatments to evaluate effects of chemical stimulants on germination. Observations recorded were: 1-first germination count at 7 days after planting (DAP); 2-final germination count at 14 days after planting (DAP); 3-total germination count at 14 days after planting (DAP); 4-pre-emergence mortality at 14 DAP; 5-post-emergence mortality at 14 DAP. Germination speed index (Nakagawa, 1992) was used to quantify seed, seedling vigour and the planting value of seed lots. Seedling evaluation was done daily starting from the time first normal seedlings appeared.

III. RESULTS

Chemical stimulants exerted significant differences in first germination count, final germination count, pre-emergence mortality, post-emergence mortality and germination speed of index in LAF-4 castor accession compared with the control (Table 1).

Treating LAF-4 accession with either coconut milk or KNO_3 or aluminum tetraflouride produced higher final germination count and germination speed index, and lower total mortality of seeds.

LAF-11 plants treated with potassium nitrate @ 15% produced higher final germination count and lower total seed mortality followed by aluminum tetraflouride @ 200mg/L; while potassium nitrate @ 15% and coconut milk @ 15% yielded significantly higher germination speed index (Table 2).

Results on effects of chemical stimulants on seed germination of AKW-5 castor accession are presented in Table 3. Seeds soaked in 15% of coconut milk for 24 hours were significantly higher in final germination count, germination speed index and lower in total mortality. AKW-5 plants treated with fusicoccin @ 200mg/L gave satisfactory results in all the germination characteristics. Table 4 shows that seeds of AKW-7 accession soaked in 15% of coconut milk for 24 hours were also significantly higher in first germination count, final germination count, germination speed index, but lower in total mortality. Year x chemical stimulant interaction on germination characteristics was not significant in all the castor accessions studied.

IV. DISCUSSION

The higher total germination, low mortality rate and higher germination speed index observed with 15% of coconut milk, 200mg/L of AIF_4 and 15% of KNO_3 in Tables 1 to 4 could be attributed to the stimulative or regulatory effects of these stimulants plant growth regulators on seed germination. Plant growth regulators are organic compounds that regulate aspects of growth, development and yield of botanical species in very small concentrations. Coconut milk contains a crude cytokinin, trans zeatin, which stimulates cell division. Dormancy breaking and germination is one of the many physiological processes under the control of plant growth regulators (Nickell, 1978). Trans zeatin stimulates the activity of gibberellic acid (GA_3) in embryos which in turn stimulates seed germination (Reibott and Blevins, 1998).

Aluminum tetraflouride (AIF4), an activator of the G-proteins is capable of influencing biological systems such as cell division, cell expansion, dormancy breaking and seed germination (May and Nordstrom, 1991). High concentrations of AIF4 lead to aluminum toxicity. Potassium nitrate (KNO_3) is involved in many regulatory mechanisms. In this trial, KNO_3 was used to test its effect on seed germination. This result showed that KNO_3 had a positive stimulative effect (probably cell division or elongation of growth axis) on seed germination. Experiments conducted under controlled conditions revealed that application of KNO_3 to the steeping solution, made hypocotyl extension more rapid under dry conditions (Haerdter and Krauss, 1999).

In this study, the effects of 15% of coconut milk, 200mg/L of AIF4, and 15% of KNO_3 on seeds of castor accessions produced significantly higher total germination and germination speed index, but lower total mortality. This means that 15% of coconut milk, 200mg/L of AIF4, and 15% of KNO_3 are good stimulants of castor seed germination, particularly 15% of coconut milk followed by 15% of KNO_3. It is therefore hoped that the information reported in this study will not only extend the cultivation of castor but also serve as a basis for further research work on crop husbandry with respect to seed dormancy, seed germination, growth, yield and quality of castor.

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AUTHORS

First Author – Msaakpa T. S, Department of Plant Breeding and Seed Science, University of Agriculture, Makurdi, Nigeria
Second Author – Obasi M. O, Department of Crop Production, University of Agriculture, Makurdi, Nigeria

Table 1. EFFECTS OF CHEMICAL STIMULANTS ON SEED GERMINATION OF CASTOR ACCESSION LAF-4 IN 2007 AND 2008 (COMBINED DATA).

Treatments	First germination count, 7 days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds	Germination speed Index
Control (untreated seeds)	1.67	4.00	6.00	0.00	6.00	26.33
2, 4-D @ 200mg/L	2.17	4.50	5.50	0.00	5.50	27.50
Coconut milk @ 15%	3.17	7.17	3.00	0.00	3.00	31.17
ALF_4 @ 200mg/L	3.17	7.00	2.83	0.00	2.83	31.33
KNO_3 @ 15%	3.50	6.83	3.17	0.00	3.17	31.33
Fusicoccin @ 200mg/L	3.50	6.67	3.33	0.00	3.33	31.17
Ethrel @ 200mg/L	3.33	5.83	4.17	0.00	4.17	30.17
$LSD_{(0.05)}$	0.679	0.635	0.635	NS	0.635	1.270
CV (%)	20.8	9.6	12.3	0.0	12.3	3.7

Key

2, 4-D = 2, 4-dichlorophenoxyacetic acid

ALF4 = Aluminum tetraflouride

KNO_3 = Potassium nitrate

Table 2. EFFECTS OF CHEMICAL STIMULANTS ON SEED GERMINATION OF CASTOR ACCESSION IN LAF-11 2007 AND 2008 (COMBINED DATA).

Treatments	First germination count, 7 days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds	Germination speed Index
Control (untreated seeds)	1.67	3.67	6.33	0.00	6.33	26.00
2, 4-D @ 200mg/L	2.67	5.50	4.50	0.00	4.50	29.17
Coconut milk @ 15%	4.33	7.17	2.83	0.00	2.83	32.507
ALF_4 @ 200mg/L	3.83	7.33	2.67	0.00	2.67	32.17
KNO_3 @ 15%	4.00	7.67	2.33	0.00	2.33	32.67
Fusicoccin @ 200mg/L	3.50	7.33	2.67	0.00	2.67	31.83
Ethrel @ 200mg/L	3.50	6.33	3.67	0.00	3.67	30.83
$LSD_{(0.05)}$	0.657	0.679	0.679	NS	0.679	1.224
CV (%)	17.8	9.5	14.7	0.0	14.7	3.5

Key

2, 4-D	=	2, 4-dichlorophenoxyacetic acid
ALF4	=	Aluminum tetraflouride
KNO_3	=	Potassium nitrate

Table 3. EFFECTS OF CHEMICAL STIMULANTS ON SEED GERMINATION OF CASTOR ACCESSION AKW-5 IN 2007 AND 2008 (COMBINED DATA).

Treatments	First germination count, 7 days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds Seedlings	Total mortality of seeds	Germination speed Index
Control (untreated seeds)	1.83	4.00	6.00	0.00	6.00	26.67

2, 4-D @ 200mg/L	2.50	6.00	4.00	0.00	4.00	29.50
Coconut milk @ 15%	4.33	8.17	1.83	0.00	1.83	33.50
ALF_4 @ 200mg/L	4.33	7.50	2.50	0.00	2.50	32.83
KNO_3 @ 15%	3.83	7.83	2.17	0.00	2.17	32.67
Fusicoccin @ 200mg/L	4.50	7.83	2.17	0.00	2.17	33.33
Ethrel @ 200mg/L	3.83	7.33	2.67	0.00	2.67	32.17
$LSD_{(0.05)}$	0.64	0.68	0.66	NS	0.66	1.22
CV (%)	15.8	8.5	16.3	0.0	16.3	3.4

Key

2, 4-D	=	2, 4-dichlorophenoxyacetic acid
ALF4	=	Aluminum tetraflouride
KNO_3	=	Potassium nitrate

Table 4. EFFECTS OF CHEMICAL STIMULANTS ON SEED GERMINATION OF CASTOR ACCESSION AKW-7 IN 2007 AND 2008 (COMBINED DATA).

Treatments	First germination count, 7 days after planting	Final germination count, 14 days after planting	Pre-emergence mortality of seeds	Post-emergence mortality of seeds	Total mortality of seeds	Germination speed Index
Control (untreated seeds)	2.00	4.17	5.83	0.00	5.83	27.00
2, 4-D @ 200mg/L	2.67	6.00	4.00	0.00	4.00	29.67
coconut milk @ 15%	4.50	8.33	1.67	0.00	1.67	33.67
ALF_4 @ 200mg/L	4.00	7.33	2.67	0.00	2.67	32.33
KNO_3 @ 15%	4.00	8.17	1.83	0.00	1.83	33.17
Fusicoccin @ 200mg/L	4.33	7.33	2.67	0.00	2.67	32.67
Ethrel @ 200mg/L	3.33	6.83	3.17	0.00	3.17	31.17
$LSD_{(0.05)}$	0.635	0.720	0.720	Ns	0.720	1.164
CV (%)	16.0	9.3	17.8	0.0	17.8	3.2

Key

2, 4-D = 2, 4-dichlorophenoxyacetic acid

ALF4 = Aluminum tetraflouride

KNO_3 = Potassium nitrate