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EFFECTS OF CHEMICAL STIMULANTS ON THE YIELD AND SEED QUALITY OF CASTOR (*Ricinus communis* L.)

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ABSTRACT

A study was undertaken at the Teaching and Research Farm, University of Agriculture, Makurdi in 2007 and 2008 to determine the effects of chemical stimulants on the yield and seed quality of castor. Six chemical stimulants viz: 2, 4-D @ 200mg/L, coconut milk @ 15%, potassium nitrate @ 15%, Aluminum tetrafloride @ 200mg/L, Fusicoccin @ 200mg/L, Ethrel @ 200mf/L; and four castor accessions: LAF-4, LAF-11, AKW-5 and AKW-7 were the treatments used. Data were collected on number of seeds per plant, number of panicles per plant, number of capsules per panicle, number of capsules per plant, dry weight of harvestable materials, total dry weight of plant, harvest index, oil yield and seed yield. In addition, total percentage viability, seed oil content, seed crude protein, 100 seed weight and content of germination inhibitors were also taken. Result revealed that AKW-5 castor accession significantly produced higher seed yield of 983.1kg/ha than LAF-4, LAF-11 and AKW-7 that produced seed yield of 879.3kg/ha, 762.6kg/ha and 549.4kg/ha respectively. Also, AKW-5 produced number of capsules per panicle, total dry weight of plant, 100 seed weight and oil yield which were significantly higher than that of LAF-11 and AKW-7. Furthermore, LAF-4 accession significantly produced higher number of seeds per plant, number of panicles per plant, number of capsules per plant than that of other accessions. Interaction between AKW-5 and 15% of coconut milk produced significantly higher yield than other accession and chemical stimulant interactions. Seeds of AKW-5 were significantly higher in ether extract, while LAF-4 accession produced significantly higher crude fibre. AKW-5 accession showed greater potential for castor seed production than LAF-4, LAF-11, and AKW-7 and should be adopted by farmers under Makurdi conditions.

Keywords: castor accessions, chemical stimulants, yield, seed quality.

INTRODUCTION

Plant growth, development and yield are under the control of both environmental stimuli and endogenous developmental programs. In both cases, plant hormones coordinate adaptive changes in cellular division and differentiation (Zhao *et al*., 2002). The chemical stimulants used in this study are basically plant growth regulators. Farmers have been in the practice of applying inorganic fertilizers to increase the yield potential of crops. There is therefore, a dearth of information on the response of castor to some chemical stimulants with respect to yield and seed quality.

2, 4-dichlorophenoxyacetic acid (2, 4-D) is a synthetic auxin-dependent chemical at very low concentrations of parts per million. Experiments with 2, 4-D using the tobacco cell line cv Virginia Bright Italia (vB1-0) demonstrated that 2, 4-D preferentially and efficiently promotes cell division but not cell elongation (Prisca and Nick, 2005). Aluminum tetra fluoride (AlF4) an activactor of the G-proteins, behaves like an auxin and can induce cell division even in the absence of any exogenous auxin (Napier *et al*., 2002). A wide range of physiological processes are influenced by the diterpene glucoside, fusicoccin: they include cell enlargement, seed germination, stomatal opening and ion exchange (De Witt, 1995).

Coconut milk is a local source of cytokinin and therefore a cell division promoter. Single treatments of 10% and 15% coconut milk resulted in significantly increased plant height, chlorophyll content, and yield of *Abelmoschus esculentus L., Hibiscus sabdariffa* and *Solanum gilo* L. (Mukaila *et al*., 2005). Field trials showed that by applying potassium nitrate, the grain yield as well as the protein content in the grains could be increased (Cakmak, 2003). The benefial effect of potassium refers to the impact potassium has on phloem loading and nitrogen metabolism. Applying adequate potassium (100kg/ha KNO_3) in split application to soybean increased the seed yield by 26% and oil yield by 34% (Keen and Zidenberg-Cher, 2000).

One major limitation to large scale production of castor in Nigeria has been the problem of low yield due to inappropriate production practices. Farmers hardly use chemical stimulants (exogenous growth regulators) to improve the yield potential of crops. This study therefore intends to determine the effects of selected plant hormones (chemical stimulants) on the yield and seed quality of castor.

MATERIALS AND METHODS

Crops of castor (*Ricinus communis* L.) accessions were produced at the Teaching and Research Farm of the University of Agriculture, Makurdi in 2007 and 2008. Sowing was done on May 10, 2007 and repeated on May 15, 2008. Thinning to one seedling per stand was done three weeks after sowing (WAS). The experiment was laid out in Randomized Complete Block Design with three replications. Four castor accessions namely: LAF-4, LAF-11, AKW-5, AKW-7 and six chemical stimulants viz: 2, 4-D, Coconut milk, Aluminum tetraflouride, Potassium

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nitrate, Fusicoccin and Ethrel were used as treatments. The gross plot size was 8m x 9.9m (79.2m^2) with net plot size of 7.2m^2. The plots were weeded manually twice, before and after flowering at 30 and 60 days intervals. Split foliar application of chemical stimulants was done at 40 days after sowing and at one week after flowering at the rate of: 200mg/L of 2, 4-D, 15% of Coconut milk, 200mg/L of AIL4, 200mg/L of Fusicoccin and 200mg/L of Ethrel. Potassium nitrate at 100kg/ha was applied basal to all the plots. The plants were sprayed with Vetox 85 insecticides at the rate of 1.1kg chemical per 225 litres of water starting from 9 WAS to minimize insect damage by weevils, leaf rollers, aphids and grasshoppers.

Data on yield traits collected from five randomly selected plants were recorded at physiological maturity (28 WAS) as follows: number of seeds per plant, number of panicles per plant, number of capsules per plant, number of seeds per panicle per plant, harvest index, 100 seed weight (g), total dry matter of plant (g), dry weight of marketable material per plant (g), seed yield (kg/ha) and oil yield (%). Seed quality was evaluated on the basis of: total percentage viability, seed oil content (%), seed crude protein (%), moisture (%), ash (%), crude fibre (%) and content of germination inhibitors (microgram/gram dry weight). Data collected in respect of all the parameters were subjected to analysis of variance (ANOVA). Where significant differences were obtained, means were separated using Fisher's Least Significant Difference procedure (F-LSD) at 5% level of probability.

RESULTS

Table-1 shows that chemical stimulants significantly influenced all the yield parameters which were higher under 15% of coconut milk. Significant differences in the yield parameters were also observed among the castor accessions with LAF-4 accession being significantly higher in number of seeds per plant, number of capsules per plant, and dry weight of harvestable material than other accessions.

Table-1 also shows higher total dry weight of plant and harvest index with LAF-4 accession, higher test weight, number of capsules per panicle and seed yield with AKW-5 accession and higher oil yield with AKW-7 accession which were significantly different. There was significant chemical stimulants and castor accessions interaction on all the yield parameters at 28 WAS being higher under 15% of coconut milk x LAF-4 and AKW-7 on number of seeds per plant, and 15% of coconut milk x LAF-4 and AKW-5 on all other parameters (Tables 2 and 3). Significantly higher 15% of KNO_3 x LAF-4 interactions on total dry weight of plant was also observed (Table-3). Number of capsules per panicle and dry weight of harvestable material exhibited significant chemical stimulant x castor accession interactions at 28 WAS which was higher under 15% of coconut milk x all castor accessions followed by 15% of KNO_3 x all castor accessions (Table-2). Also, chemical stimulant x castor accession interaction of total dry weight of plant, harvest index, and seed yield was observed to be significant at 28 WAS and higher under 15% of coconut milk x all castor accessions followed by 15% of KNO_3 x all castor accessions (Table-3). Oil yield showed significant chemical stimulant x castor accession interaction at 28 WAS which was higher under 15% coconut milk x all castor accessions followed by 200mg/L AIF_4 x all castor accessions (Table-4). Results on the seed quality of castor accessions (Table-5) shows that chemical stimulants exerted significant difference in crude protein, ether extract (oil content) and crude fibre for each castor accession. Potassium nitrate at 15% significantly produced higher crude protein and ether extract than that of other chemical stimulants. The stimulative effects of coconut milk @ 15% and AIF_4 @ 200mg/L produced higher crude fibre which was significantly different. The seeds of AKW-7 accession were higher in moisture content but lower in crude fibre (Table-5). AKW-5 accession was significantly higher in ether extract compared to LAF-4 accession, while LAF-4 accession produced significantly higher crude fibre.

DISCUSSIONS

The results of this study in which number of seeds per castor plant were higher with application of coconut milk @ 15% agrees with the findings of Reinbott and Blevins (1998). The authors observed increases in seed number and pod number of soybean due to crude cytokinin (coconut milk) application. The inhibitory effect of Ethrel was essentially responsible for the lower number of seeds observed in all castor accessions. Ethrel often reduces grains per spike and grain mass (Moes and Stobbe, 1991b). Higher number of panicles per plant with 200mg/L of AIF_4 in LAF-4 and LAF-11 castor accessions; and with 15% of coconut milk in AKW-5 and AKW-7 accessions could be attributed to the regulation of photosynthetic activity and dry matter accumulation by coconut milk and AIF_4. AIF_4 behaves like a synthetic auxin and controls many fundamental aspects of physiological processes leading to yield increases (Sachs, 2001). As a result of the same stimulative effect of 15% of coconut milk on castor plants, higher number of capsules per panicle and capsules per plant were observed.

The photosynthetic influence caused by the stimulative effect of coconut milk @ 15% was probably responsible for higher dry matter production and hence higher dry weight of harvestable material and total dry weight of plant. The observed increase in nodule weight of plant in coconut milk treatment indicated the distinct role of cytokinin in nodule morphogenesis (Hirsch and Fang, 1994). The physiological influence of coconut milk treatment resulted in higher oil yield with LAF-4 and AKW-5; and AIF_4 and KNO_3 treatments led to higher increase in oil yield with LAF-11 and AKW-7 accessions. Dybing and Lay (1982) reported that application of PGRs on plant improves the quality and quantity of oil, latex, sucrose, proteins and fatty acid composition. The higher seed yield observed in castor accessions was probably caused by the physiological influence of coconut milk @ 15%. Treatment of 10-15% of coconut milk resulted in

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significantly increased chlorophyll contents and yield of *Solanum melongena* (Olympios, 1976).

The study therefore, concluded that AKW-5 castor accession produced higher yield followed by LAF-4. Furthermore, coconut milk @ 15%, KNO_3 @ 15% and 200mg/L of AIF_4 should be recommended for use by farmers to improve the yield capacity and seed quality of castor, particularly coconut milk @ 15% because it is easily affordable.

Table-1. Effects of chemical stimulants and castor accessions on yield characters at harvest maturity in 2007 and 2008 (combined data).

Treatments	No. of seeds per plant	No. of panicles per plant	No. of capsules per panicle	No. of capsules per plant	Dry wt. of harvestable material (g)	Total dry weight of plant (g)	Harvest index	Test weight (g)	Oil yield (%)	Seed yield (kg/ha)
Chemical stimulants										
2, 4-D @ 200mg/L	419.00	4.25	33.00	139.60	84.22	189.35	0.45	6.70	46.00	658.50
Coconut milk @ 15%	603.00	6.25	33.50	201.00	98.27	198.63	0.48	7.93	48.75	907.90
ALF_4 @ 200mg/L	529.00	6.00	28.75	178.00	92.76	185.92	0.46	7.52	48.13	845.00
KNO_3 @ 15%	505.00	5.50	30.75	170.00	89.15	197.43	0.44	7.55	46.75	890.00
Fusicoccin @ 200mg/L	456.00	5.25	29.00	152.00	82.30	195.02	0.41	7.20	45.63	775.60
Ethrel @ 200mg/L	373.00	4.50	27.75	124.20	70.42	197.82	0.36	6.95	45.63	684.70
$LSD_{(0.05)}$	77.60	0.77	3.43	24.59	6.26	1.67	0.02	0.11	0.28	9.65
Castor accessions										
LAF-4	538.00	5.83	31.67	181.60	109.83	200.33	0.53	6.95	46.58	879.30
LAF-11	484.00	5.33	30.17	161.30	83.92	197.57	0.42	7.28	46.67	762.60
AKW-5	488.00	4.83	33.50	162.50	98.87	201.38	0.49	8.18	46.83	983.10
AKW-7	414.00	5.17	26.50	137.80	52.14	176.82	0.29	6.82	47.17	549.40
$LSD_{(0.05)}$	63.40	0.63	2.80	20.08	5.11	1.37	0.02	0.09	0.23	7.88

Key
NS = Not significant

Table-2. Effects of chemical stimulant x castor accessions interaction on number of seeds per plant, number of panicles per plant, number of capsules per panicle and dry weight of harvestable material at harvest maturity in 2007 and 2008 (combined data).

	Number of seeds per plant				Number of panicles per plant				Number of capsules per panicle				Dry weight of harvestable material			
Chemical Stimulants	LAF-4	LAF-11	AKW-5	AKW-7	LAF-4	LAF-11	AKW-5	AKW-7	LAF-4	LAF-11	AKW-5	AKW-7	LAF-4	LAF-11	AKW-5	AKW-7
2, 4-D@ 200mg/L	387.00	414.0	180.00	162.00	4.00	3.67	3.33	3.00	43.00	30.00	36.0	23.00	91.30	67.40	63.10	47.20
Coconut milk @ 15%	819.00	333.00	273.00	414.00	8.00	4.33	8.00	5.00	36.00	33.00	36.00	30.00	134.20	96.00	131.00	58.13
ALF_4 @ 200mg/L	405.00	264.00	369.00	300.00	5.33	4.33	5.33	4.33	24.00	29.00	32.00	25.00	112.40	89.70	106.70	52.40
KNO_3 @ 15%	753.00	486.00	408.00	246.00	7.00	4.33	5.33	5.33	32.00	31.00	34.00	29.00	116.50	90.50	108.60	54.30
Fusicoccin @ 200mg/L	744.00	360.00	396.00	330.00	6.00	5.00	5.00	4.33	28.00	30.00	33.00	26.00	107.60	87.60	101.30	51.50
Ethrel @ 200mg/L	690.00	300.00	378.00	270.00	6.00	4.33	4.33	4.33	27.00	28.00	30.00	25.00	97.00	72.30	82.50	49.30
$LSD_{(0.05)}$		13.18					1.13				6.85			12.52		

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Table-3. Effects of chemical stimulant x castor accessions interaction on total dry weight (g) of plant, harvest index, test weight and seed yield at harvest maturity in 2007 and 2008 (combined data).

	Total dry weight of plant				Harvest index				Test weight				Seed yield			
Chemical Stimulants	**LAF-4**	**LAF-11**	**AKW-5**	**AKW-7**	**LAF-4**	**LAF-11**	**AKW-5**	**AKW-7**	**LAF-4**	**LAF-11**	**AKW-5**	**AKW-7**	**LAF-4**	**LAF-11**	**AKW-5**	**AKW-7**
2, 4-D@ 200mg/L	200.20	202.00	185.20	170.00	0.48	0.37	0.70	0.26	6.00	6.50	7.80	6.50	715.90	506.90	934.40	476.70
Coconut milk @ 15%	209.40	204.33	209.00	182.00	0.63	0.47	0.51	0.32	7.50	8.10	9.60	7.00	1004.90	1041.50	1134.90	593.90
ALF_4 @ 200mg/L	187.40	178.80	200.00	177.50	0.54	0.44	0.48	0.29	7.30	7.30	7.67	6.90	924.20	790.60	1066.70	576.20
KNO_3 @ 15%	210.00	201.00	206.00	181.40	0.55	0.45	0.51	0.29	7.40	7.60	8.60	7.00	948.70	826.20	1081.30	583.30
Fusicoccin @ 200mg/L	200.00	190.00	206.10	180.00	0.52	0.44	0.40	0.28	7.00	7.20	7.80	6.80	877.30	719.90	935.90	569.30
Ethrel @ 200mg/L	195.00	209.00	205.00	172.00	0.47	0.37	0.31	0.27	6.50	7.00	7.60	6.70	805.90	690.70	745.30	496.80
LSD $_{(0.05)}$	3.35				0.04				0.21				19.30			

Table-4. Effects of chemical stimulant x castor accession interaction on oil yield at harvest maturity in 2007 and 2008 (combined data).

Chemical stimulants	**Castor accession**			
	LAF-4	**LAF-11**	**AKW-5**	**AKW-7**
2, 4-D @ 200mg/L	46.00	46.00	46.00	46.00
Coconut milk @ 15%	49.00	48.00	49.00	49.00
ALF_4 @ 200mg/L	48.00	48.00	48.00	48.50
KNO_3 @ 15%	45.50	47.00	47.00	47.50
Fusicoccin @ 200mg/L	45.50	45.00	45.50	46.00
Ethrel @ 200mg/L	45.50	45.00	45.50	46.00
LSD $_{(0.05)}$	0.55			

Table-5. Proximate composition of seeds of castor accessions as influenced by chemical stimulants in 2007 and 2008 (combined data).

LAF-4

Chemical Stimulants	**Moisture** (%)	**Crude protein** (%)	**Ether extract** (%)	**Crude fibre** (%)	**Viability** (%)	**Abscisic acid** (microgram/g dry weight)
2, 4-D @ 200mg/L	17.60	35.00	52.60	9.70	97.00	0.50
Coconut milk @ 15%	17.60	35.00	52.60	11.00	98.00	0.50
AIF_4 @ 200mg/L	17.60	35.00	52.60	11.00	98.00	0.50
KNO_3 @ 15%	17.60	40.00	62.80	9.20	98.00	0.50
Fusicoccin @ 200mg/L	17.60	35.00	52.60	9.70	97.00	0.50
Ethrel @ 200mg/L	17.60	35.00	52.60	9.70	98.00	0.50
LSD (0.05)	NS	0.523	0.453	0.412	NS	NS

LAF-11

2, 4-D @ 200mg/L	11.60	35.00	53.00	8.15	98.00	0.50
Coconut milk @ 15%	11.60	35.00	53.00	9.45	99.00	0.50
AIF_4 @ 200mg/L	11.60	35.00	53.00	9.45	99.00	0.50
KNO_3 @ 15%	11.60	40.00	63.20	7.65	98.00	0.50
Fusicoccin @ 200mg/L	11.60	35.00	53.00	8.15	98.00	0.50
Ethrel @ 200mg/L	11.60	35.00	53.00	8.15	98.00	0.50
LSD (0.05)	NS	0.523	0.453	0.412	NS	NS

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			AKW-5			
2, 4-D @ 200mg/L	19.80	35.00	55.60	6.60	99.00	0.50
Coconut milk @ 15%	19.80	35.00	55.60	7.80	99.00	0.50
AIF_4 @ 200mg/L	19.80	35.00	55.60	7.80	99.00	0.50
KNO_3 @ 15%	19.80	40.00	65.80	6.60	99.00	0.50
Fusicoccin @ 200mg/L	19.80	35.00	55.60	6.60	99.00	0.50
Ethrel @ 200mg/L	19.80	35.00	55.60	6.60	98.00	0.50
LSD (0.05)	NS	0.523	0.453	0.412	NS	NS
			AKW-7			
2, 4-D @ 200mg/L	23.20	35.00	52.80	5.80	98.00	0.50
Coconut milk @ 15%	23.20	35.00	52.80	7.10	98.00	0.50
AIF_4 @ 200mg/L	23.20	35.00	52.80	7.10	98.00	0.50
KNO_3 @ 15%	23.20	40.00	63.00	5.80	98.00	0.50
Fusicoccin @ 200mg/L	23.20	35.00	52.80	5.80	98.00	0.50
Ethrel @ 200mg/L	23.20	35.00	52.80	5.80	98.00	0.50
LSD (0.05)	NS	0.523	0.453	0.412	NS	NS

REFERENCES

Cakmak I. 2003. The role of potassium in alleviating detrimental effects of abiotic stresses in plants. In: Proceedings of the IPI Golden Jubilee Congress, October 8-10, 2002, Basel, Switzerland. pp. 325-343.

De Witt P. J. G. M. 1995. Fungal avirulence genes and plant resistance genes: Unraveling the molecular basis of gene for gene interactions. Adv. Bot. Res. 21: 148-177.

Dybing C. D. and Lay C. 1982. Oil and protein in field crops treated with morph actins and other growth regulators for senescence delay. Crop Sci. 22: 1100-1109.

Hirsch A. M. and Fang Y. 1994. Plant hormones nodulation: what's the connection. Plant Mol. Biol. 26: 5-9.

Keen C. L. and Zidenberg-Cher S. 2000. What are the best strategies for achieving optimal nutrition? California Agriculture. September – October. pp. 12-18.

Moes J. and Stobbe E. J. 1991b. Barley treated with ethephon. II. Tillering pattern and its impact on yield. Agron. J. 83: 90-94.

Mukaila A., Nitsch J. P. and Rhodes M. J. C. 2005. Growth factors in the tomato fruit. In: Plant Growth Regulation. 4th International conference on plant growth regulation, Yonkers, NY. 2003, Ames Iowa State Univ. press. pp. 680-700.

Napier R. M., David K. M. and Perrot -Rechenmann C. 2002. A short history of auxin -binding proteins. 49: 339-348 (Pub Med).

Olympios C. M. 1976. Effect of growth regulators on fruit-set and fruit development of the egg plant (*Solanum melongena*) Hort. Res. 16: 65-70.

Prisca C. and Nick P. 2005. Auxin-dependent cell division and cell elongation. I-Naphthalene acetic acid and 2, 4-dichlorophenoxyacetic acid activates different pathways. Plant Physiol. 137(3): 939-948.

Reinbott T. M. and Blevins D. G. 1998. Cytokinin stem in fusion increased soybean pod and seed numbers. Soil Sciences Society of America. Baltmore Maryland, October. pp. 18-22.

Sachs T. 2001. Plant morphogenesis: long-distance coordination and local patterning. Curr Opin Plant Biol. 4: 57-62.

Zhao H., Hertel R., Ishikawa H. and Evans M. L. 2002. Species differences in ligand specification, elongation and auxin transport: comparing Zea and Vigna. Planta. 216: 293-301, (Pub Med).