International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 2, 2020, pp.-9412-9414.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

PHYSIOLOGICAL SCREENING FOR HIGH WATER USE EFFICIENCY IN GAMMA RADIATED COWPEA VARIETIES (*Vigna unguiculata* L.)

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Received: January 02, 2020; Revised: January 24, 2020; Accepted: January 27, 2020; Published: January 30, 2020

Abstract: Gamma rays are often used on plants in developing varieties that are agriculturally and economically important and have high productivity potential, Gamma irradiation can be useful for the alteration of one or a few physiological characters Mutagenesis by means of gamma rays has played an important role in the producing new mutants with improved properties which can produce higher amounts of commercially important metabolites. Cowpea (*Vigna unguiculate* L. Walp) is one of the world's dicotyledonous leguminous food crops and a major food crop of millions of people in the developing countries. The present programme was an attempt to study the seed germination test and morpho- physiological traits of cowpea seed treated by gamma radiation and Biochemical observation on Cowpea varieties treated with gamma radiation. Plant responses in terms of growth parameters, leaf characters were analyzed. The result indicated an improvement in growth performances of cowpea varieties under gamma radiation.

Keywords: *Cowpea, Growth, Gamma Radiation, Genotypes*

Citation: Srikanth G.A., *et al*., (2020) Physiological Screening for High Water Use Efficiency in Gamma Radiated Cowpea varieties (*Vigna unguiculata* L.). International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 2, pp.- 9412-9414.

Academic Editor / Reviewer: Rajpal Diwakar, Y. S. Saitwal, Tomislav Tosti

Introduction

The world total production of cowpea about 12.5 million/ha grown to cowpea with a production of 3 million tonnes (t). However, reports on the response of the crop to drought at different stages of growth are inconsistent although significant results. Despite all its economic importance in Sub-saharan Africa, cowpea production is subjected to a wide range of biotic and abiotic constraints [1]. Irradiation also been successfully used for mutation in breeding of various crops and ornamental plants. The gamma irradiation was very useful not only for sterilization of medicine but also for the preservation of food and cereals in nutrition and agriculture. The improvement of yield components and chlorophyll parameters in plants was induced after various mutagenic treatments [2, 3].

Materials and Methods

The present study entitled "Physiological screening for high water use efficiency in gamma radiated Cowpea varieties (*Vigna unguiculata* L.)", was conducted in the research field. A pot culture experiment was conducted on cowpea varieties at the Department of Plant Physiology, SHIATS, Allahabad. The experiment laid out in randomized block design (RBD) within five treatments, four verities, each replicated tree times. Experimental Materials four varieties of Cowpea (*Vigna unguiculata* L.) namely HR-1, BG-12, Ankur Gomati, Khashi kanchan were purchased from local market Allahabad, UP. Seeds treated by Gamma radiation with the source of Co-60 in National Botanical Research Institute (NBRI) research institute of CSIR at Lucknow.

Estimation of chlorophyll

The chlorophyll content in the leaves was estimated by weighing 0.1 gm of fresh leaves and then homogenized in 10 ml of 80% acetone with the help of mortar and pestle. The whole contents were transferred into centrifuge tubes and centrifuged at 3000rpm for about 10 minutes. The absorbance was read at 663 and 645 nm respectively on U.V. Spectrophotometer. The Chlorophyll was calculated by following equation:

Chlorophyll a (mg/g fresh weight) = 12.21 (A_{663})- 2.82(A_{645})
Chlorophyll b (mg/g fresh weight) = 20.13(A_{645})- 5.03 A_{663})
Total Chlorophyll (mg/g fresh weight) = (20.2x A_{663}+ 8.02xA_{645}) x (V/ 1000xW)

Estimation of Chlorophyll by SPAD meter

The SPAD was used to analyze the chlorophyll statues of plant. SPAD displays a three-digit value, proportional to the amount of light transmitted by the leaf i.e., two wavelength regions (600-700nm and 900-1000nm). The SPAD meter measures chlorophyll content per unit leaf area.

Statistical analysis

The experiment used an RBD with three treatments and each treatment was analyzed with three replications. Statistical analysis was performed using ANOVA.P values d ≤ 0.05 were considered as significant.

Results and Discussion

Alteration in growth performance of cowpea under the treatment of gamma radiation by analyzing the growth parameters. The Data presented in [Table-1] shows the effect of gamma radiation on seed germination percentage of different cowpea varieties. The results showed that there was a significant difference in seed germination among all the treatments. The results observed for seed germination percentage is summarized below. Significant difference in seed germination among the varieties at 6 DAS. The maximum seed germination percentage was observed in variety Ankur Gomati- 30% (control), whereas the minimum was observed in variety Ankur Gomati- 10 % (at 40 Gy of gamma radiation) under all the treatments [Fig-1]. At 12 DAS, the data showed that there was a significant difference in seed germination among the varieties. The maximum seed germination percentage was observed in variety Ankur Gomati- 60% (control), whereas the minimum was observed in variety HR-1- 10% (at 40 Gy of gamma radiation), under all the treatments.

Table-1 *Effect of gamma radiation on cowpea varieties in Seed germination percentage between six days intervals*

Varieties	6 DAS						12 DAS						18 DAS					
	Seed germination (%)						Seed germination (%)						Seed germination (%)					
	T_0	T_1	T_2	T_3	T_4	Var. Mean	T_0	T_1	T_2	T_3	T_4	Var. Mean	T_0	T_1	T_2	T_3	T_4	Var. Mean
V_1	10	0	0	0	0	2	20	20	10	20	10	16	80	60	50	60	40	58
V_2	20	10	10	0	0	8	40	30	30	20	20	28	80	70	60	60	40	62
V_3	30	20	20	10	0	16	60	40	40	30	0	34	70	70	60	70	50	64
V_4	20	10	10	0	0	8	30	30	20	20	20	24	90	80	70	60	60	72
Treatment Mean	20	10	10	2.5	0	8.5	37.5	30	25	22.5	12.5	25.5	80	70	60	62.5	47.5	64
	Seed germination (%)			Varieties		Interaction	Seed germination (%)			Varieties		Interaction	Seed germination (%)			Varieties		Interaction
S.Ed. (±)	0.19			0.21		0.42	0.43			0.48		0.97	0.99			1.11		2.23
C.D. (P = 0.01)	0.73			0.81		1.63	1.67			1.87		3.74	3.83			4.28		8.56

Table-2 *Effect of Gamma Radiation on number of leaves of Cowpea varieties at various growth stages*

Varieties	15DAS						30 DAS						45 DAS					
	No of leaves						No of leaves						No of leaves					
	T_0	T_1	T_2	T_3	T_4	Var. Mean	T_0	T_1	T_2	T_3	T_4	Var. Mean	T_0	T_1	T_2	T_3	T_4	Var. Mean
V_1	8	6	6	8	4	6.4	18	12	14	16	8	13.6	44	34	32	32	30	34.4
V_2	7	4	4	6	4	5.0	26	16	14	12	9	15.4	42	36	32	28	32	34.0
V_3	8	6	4	7	4	5.8	32	20	18	19	16	21	52	36	30	28	28	34.8
V_4	8	6	4	6	2	5.2	30	18	17	16	14	19	41	32	32	26	25	31.2
Treatment Mean	7.75	5.5	4.5	6.75	3.5	5.6	26.5	16.5	15.7	15.7	11.7	17.2	44	34	32	32	30	34.4
	No of leaves			Varieties		Interaction	No of leaves			Varieties		Interaction	No of leaves			Varieties		Interaction
S.Ed. (±)	0.08			0.10		0.20	0.27			0.31		0.62	0.52			0.58		1.17
C.D. (P = 0.01)	0.34			0.38		0.76	1.07			1.19		2.39	2.00			2.24		4.49

Table-4 *Effect of gamma radiation on Chlorophyll a (mg/g) and chlorophyll b (mg/g) content in different cowpea variety*

Varieties	Chlorophyll 'a' (mg/g) FW						Chlorophyll 'b' (mg/g) FW					
	T0	T1	T2	T3	T4	Var. mean	T0	T1	T2	T3	T4	Var. mean
V1	1.29	1.28	1.23	1.06	0.33	1.03	0.90	0.84	0.70	0.68	0.20	0.66
V2	1.72	1.61	1.48	1.46	1.07	1.46	0.40	0.37	0.35	0.32	0.31	0.35
V3	1.99	1.80	1.76	1.60	1.24	1.67	1.20	0.80	0.55	0.42	0.35	0.66
V4	1.24	1.12	1.02	0.71	0.21	0.86	0.89	0.84	0.70	0.54	0.40	0.67
Treatment mean	1.56	1.45	1.37	1.20	0.71	1.26	0.84	0.71	0.57	0.49	0.31	0.58
	Chlorophyll 'a'		Varieties		Interaction		Chlorophyll 'b'		Varieties		Interaction	
S.Ed. (±)	0.02		0.02		0.04		0.09		0.01		0.02	
C.D. (P = 0.01)	0.07		0.08		0.17		0.03		0.04		0.08	

Fig-1 Seed germination

The maximum seed germination percentage was observed in variety Khashi Kanchan- 90% (control), whereas the minimum was observed in variety BG-12 and HR-1- 40% (at 40 Gy of gamma radiation), under all the treatments AT 18 DAS. The reduction in seed yield due to gamma radiation on number of pods per plant. Similarly, attributed the loss in seed yield to low fruiting efficiency and lack of filling time for pods [4]. Maximizing the efficiency of biomass production per unit amount of water transpired has been a major research focus of plant scientists, especially under tropical conditions [5]. Gamma rays are often used on plants in developing varieties that are agriculturally and economically important and have high productivity potential. The Data presented in [Table-2] shows the effect of gamma radiation on number of leaves of different cowpea varieties. The results showed that there was a significant difference in number of leaves among all the treatments. At 15 DAS, the data presented in [Table-2] showed that there was a significant difference in number of leaves in all the varieties under different treatments. The maximum number of leaves was observed in variety Khashi kanchan, HR-1 and Ankur gomti in control T0 (8), whereas the minimum was observed in variety Khashi Kanchan in T4 (2) at 40 Gy of gamma radiation, under all the treatments. Significant difference in plant number of leaves in all the varieties under different treatments. The maximum number of leaves was observed in variety HR-1 in control T0 (18), whereas the minimum was observed in variety BG-12 in T4 (8) at 40 Gy of gamma radiation, under all the treatments at 30 DAS. The maximum number of leaves was observed in variety Ankur Gomti in control T0 (52), whereas the minimum was observed in variety Khashi kanchan in T4 (25) at 40 Gy of gamma radiation, under all the treatments at 45 DAS. Gamma irradiation was found to increase plant growth and development by inducing cytological. There was a significant difference in number of fruits at 45 days after sowing in all the varieties under different treatments [Table-3]. The maximum number of fruits was observed in variety Khashi kanchan in control T0 (8), whereas the minimum was observed in variety BG-12 and Khashi kanchan in T4 (2) at 40 Gy of gamma radiation, under all the treatments.

Table-3 Effect of Gamma Radiation on number of fruits of Cowpea varieties at fruiting period

Varieties	45 DAS					
	No of fruiting					
	T_0	T_1	T_2	T_3	T_4	Var. Mean
V_1	6	4	3	3	2	3.6
V_2	4	4	2	2	2	2.8
V_3	6	4	4	3	4	4.2
V_4	8	3	4	4	2	4.2
Treatment Mean	6	3.7	3.2	3	2.5	3.7
	No of fruiting			Varieties		Interaction
S. Ed. (±)	0.06			0.06		0.13
C.D. (P = 0.01)	0.23			0.26		0.52

Maximizing the efficiency of biomass production per unit amount of water transpired (WUE) has been a major research focus of plant scientists, especially under tropical conditions [6]. The Data presented in [Table-4] show the effect of gamma radiation on Chlorophyll a (mg/g) and chlorophyll b (mg/g) content of different cowpea varieties. The results showed that there was a significant difference in Chlorophyll 'a' (mg/g) and chlorophyll 'b' (mg/g) content among all the treatments. The data presented in [Table-4] showed that there was a significant difference in Chlorophyll (a) content (mg/g) in all the varieties under different treatments. The maximum Chlorophyll (a) content was observed in variety Ankur Gomati in control T0 (1.99 mg/g), whereas the minimum was observed in variety Khashi Kanchan in T3 (0.21 cm) at 30 Gy of gamma radiation, under all the treatments. Significant difference in Chlorophyll (b) (mg/g) content in all the varieties under different treatments. The maximum Chlorophyll (b) (mg/g) content was observed in variety Ankur Gomati in control T0 (1.20 mg/g), whereas the minimum was observed in variety HR-1 in T4 (0.20 mg/g) at 40 Gy of gamma radiation, under all the treatments. Modification in chlorophyll mutants in both chlorophyll and morphological under gamma treatment [7-9]. The Data presented in [Table-5] show the effect of gamma radiation on chlorophyll content of different cowpea varieties with Spad meter. The results showed that there was a significant difference in chlorophyll content among all the treatments.

Table-5 Effect of gamma radiation on chlorophyll content in different varieties of cowpea by SPAD meter

Varieties	Chlorophyll Content (Spad meter)					
	T0	T1	T2	T3	T4	Var. mean
V1	61.2	59.2	49.8	42.3	41.5	50.8
V2	46.5	45.7	38.6	35.2	34.1	40.0
V3	65.8	57.8	51.4	40.82	37.5	50.6
V4	60.6	55.4	49.3	37.1	32.4	46.9
Treatment mean	58.5	54.5	47.2	38.8	36.3	47.1
	Chlorophyll Content		Varieties		Interaction	
S. Ed. (±)	0.73		0.82		1.64	
C. D. (P = 0.01)	2.82		3.16		6.32	

Conclusion

Plant productivity is determined both by the amount of water available for plants and the efficiency by which water is used by the plant. From the present study and on the basis of observation it was concluded that Khashi kanchan and HR-1 maximum growth, among all the varieties and whereas BG-12 and Aankur Gomati were gamma radiation sensitive variety. Approaches combining physiological, biochemical, and new techniques should provide exciting results in the development of new genotypes of cowpea varieties in the near future.

Application of research: Understanding response of cowpea varieties in terms of growth and development under for High water use Efficiency in Gamma Radiated Cowpea varieties (*Vigna unguiculata* L.)

Research Category: Plant Physiology

Acknowledgement / Funding: Authors are thankful to Department of Plant Physiology, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Naini, Prayagraj, 211007, Uttar Pradesh, India.

****Research Guide or Chairperson of research: Dr P.K. Shukla**
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Research project name or number: MSc Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: National Botanical Research Institute, IRMS

Cultivar / Variety / Breed name: HR-1, BG-12, A Gomati, Khashi K

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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