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Mutagenic effect of Sodium Azide on Morphological Parameters of Cowpea (*Vigna unguiculata* L.)

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ABSTRACT: A field experiment was carried out at Horticulture Farm, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan in year 2023, to study the "Mutagenic effect of sodium azide on morphological parameter of cowpea (*Vigna unguiculata* L.)". Cowpea cv. Pusa Dharni, including germination percentage, days to 50% flowering, leaf length, leaf width, pod length, pod diameter, and lethality. The germination percentages varied among treatments, as compared to control (SA_{11}) and sodium azide (0.01%) exhibiting the highest values (93% and 90% respectively), while SA_{10} (0.1%) had the lowest (40%). The control SA_3 (0.03%) and SA_2 (0.02%) treatments resulted in earlier flowering, while higher level SA_{10} (0.1%) showed delayed flowering. Leaf length and width were significantly influenced by SA_3 and SA_2 treatments with SA_{10} exhibiting the narrowest leaves. Pod length and diameter were increases in treatment SA_3, SA_2, and SA_4 level, while the higher lethality was observed in the SA_{10} (0.1%) over the control and other treatment level.

Keywords: Mutagenic, Sodium Azide, Cowpea, Pusa Dharni, and Lethality.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. walp), belongs to the family Fabaceae, chromosome number 2n = 22 and originated from Central Africa. Cowpea is important *Kharif* pulse crop and grown in India for vegetable pods, grain, forage and for green manure purpose. Cowpea is grown both for tender pods and dry seeds used as pulse for culinary purpose. Vegetable cowpea is one of the most ancient crops known to man. It is a popular vegetable grown throughout the world. It is a warm season crop, well adopted to many areas of humid tropics and subtropical zones. In India it is grown widely around the year (Dekhane *et al.*, 2011).

Cowpea pods are good source of protein, fibre, minerals, calcium and vitamins particularly Vitamin A and vitamin C. It contains 8 g carbohydrates, 43 g proteins and 0.6 g fat, 2 g fiber per 100 g of edible portion. Tender fruits contain 80 mg calcium, 74 mg phosphorus and 2.5 mg iron per 100 g fresh pod, amino acid profile particularly high in cowpea which greatly improves the protein quality of pulses (Gopalakrishnan, 2007).

In India, cowpea is cultivated in an area of 654 lakh hectares with a production of 599 lakh tonnes. The productivity of cowpea is 916 kg ha^{-1} (Anonymous, 2021a). The major cowpea growing states are Maharashtra, Karnataka, Tamil Nadu, Gujarat, Madhya Pradesh and Andhra Pradesh. In Tamil Nadu, cowpea is cultivated in an area of 65,836 hectares with production of 50,145 tonnes (2020-21) Anonymous (2021b) https://aps.dac.gov. in/APY/ Public _Report1.

It is cultivated in the semi-arid regions of Rajasthan, Gujarat, Karnataka, Tamil Nadu and Maharashtra mostly as grain legume. In India around 19.3 million tons of cowpea produced annually with average productivity of 764 kg/ha. In Rajasthan largest producers of cowpea districts are Jhunjhunu (14140 tons), Sikar (9999 tons), Jaipur (3030 tons), Churu (1730 tons) respectively and total area under cowpea in Rajasthan 50060 ha in which major area districts including are Jhunjhunu (22850 ha), Sikar (14087 ha), Jaipur (94627 ha), Nagaur (2724 ha) during 2019-20 as per Anonymous (2022).

Mutation is considered as one of the driving forces of evolution. Induced mutation breeding is relatively quicker method to create variability for quantitatively inherited traits in different plants (Camargo *et al.*, 2000). It is induced through both physical and chemical mutagens, in which gamma radiation is an important tool for inducing the genetic variability, which intern throw potential mutants for enhancing yield and its yield contributing traits (Thapa, 2004). One per cent sodium azide is utilized for inducing mutation in

sorghum for enhancing germination rate, root length, shoot length, bold seeds and yield attributing traits (Dahot *et al*., 2011).

MATERIAL AND METHODS

A field experiment was carried out at Horticulture Farm, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan in year 2023. Which is situated at 23° 34′N latitude and 72° 42′E longitudes at an elevation of 562.8 meters above mean sea level. The region falls under agro climatic Zone IV A (Sub-humid Southern Plain and Aravali Hills) of Rajasthan. The field had fairly levelled topography. The experiment was conducted on clay loam soil under irrigated condition. The experimental layout was made by preparation of ridges and furrow at a distance of 30 cm × 30cm (R × P) by manually as per the layout. The field experimental site has clayey loam soil in texture. The details of the materials used and methods adopted during the course of investigation are described in this chapter. Seed of cowpea cv. Pusa Dharni treated with 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1% sodium azide concentration at 3.0 pH buffer

A. Observations noted

Germination percentage. Germination percentage is calculated by number of germinated seed divided number of seed sown.

Days to 50 percent flowering. The number of days taken from the date of sowing to appearance of 50% flowering in half of the plant population for each treatment in a plot.

Leaf length (cm). The leaf length (cm) of selected sample plants from different treatments was measured by graduated scale in centimeters and data was analyzed for statistical significance.

Leaf width (cm). The leaf width (cm) of selected sample plants from different treatment was measured by graduated scale and recorded. The average leaf width was calculated for statistical analysis.

Pod length(cm). At harvest, length of pods was measured from the ten tagged plants and average value was recorded for statistical analysis.

Pod diameter (mm). The pod diameter of the selected ten mature pod was measured by the Venire calipers in millimeter taken from each treatment and the average diameter of the pod was calculated

Lethality. The dose of a mutagen which would kill 50% of the treated individual.

$$\text{Lethality (\%)} = \frac{\text{Number of plants survive} \times 100}{\text{Total number of seeds germinated}}$$

RESULTS AND DISCUSSION

The data pertaining to the days to 50% flowering, leaf length, leaf width, pod length, pod width and lethality are presented in Table 1 and Fig. 1-9.

The data pertaining to the germination percent (%) are presented in Table 1 and Fig. 1 & 2 It is clear from the analyse mean data that in cowpea cv. Pusa Dharni, various concentration of sodium azide lower down germination percentage in SA_{10} (0.1%) i.e. 40% followed as SA_9 (0.09%) i.e. 43% showed significant influence in treatment control SA_{11} - Control (93%) was recorded highest germination percent (%), which was at par with treatment SA_1-SA @ 0.01 (90%), respectively rest of the other treatment. The treatment SA_{10}- SA @ 0.1 (40%) recorded lowest germination percent (%) as compare to other treatment, respectively.

Among the result days to 50% flowering are presented in Table 1. It is clear from the analyse reveal mean data that in cowpea cv. Pusa Dharni showed earliest days to 50% flowering statistically SA_3 - SA @ 0.03% (43.60 day) was recorded earlier days to 50% flowering, which was at par with treatment SA_2-SA @ 0.02% (45.13 day) as compared to SA_{11} (control) *i.e.* 47.93 days respectively. The higher level of sodium azide SA @ 0.1% recorded delayed days to 50% flowering (58.40 days) as compare to other treatment.

The data in Table 1 and Fig. 5 highlights the impact of different treatments on leaf length (cm) in cowpea cv. Pusa Dharni. Improved trends for leaf length were notes from 0.02% (13.20cm) to 0.03% (13.23cm), sodium azide level and declined trend noted at SA_9 @0.09% (10.36cm) and SA_{10} @0.1% (10.00cm).

The table in Table 1 and Fig. 3 and 4 presents the data on leaf width (cm) in cowpea cv. Pusa Dharni. The analysis of mean data indicates that the treatment SA_3 - SA @ 0.03 resulted in significantly higher leaf width (7.15 cm) compared to the control treatment. Similarly, at par with the treatment SA_2 - SA @ 0.02 (6.89 cm) exhibited a similar effect. On the other hand, the treatment SA_{10} - SA @ 0.1 recorded the lowest leaf width (4.25 cm) among all the treatments.

The table (Table 1 and Fig. 6) presents data on pod length (cm) in cowpea cv. Pusa Dharni. The analysis of mean data reveals that the treatment Sodium azide 0.03% exhibited a significant influence, resulting in a higher pod length (23.51 cm) compared to the SA_{11}-control (20.92) treatment. Which was at par with treatment SA_2 - SA @ 0.02 (23.48 cm) showed a similar effect. In contrast, the treatment SA_{10} - SA @ 0.1 recorded the lowest pod length (15.00 cm) among all the treatments.

The data pertaining to the pod diameter (mm) are presented in Table 1 and Fig 9. It is clear from the analyse mean data that in cowpea cv. Pusa Dharni showed significant influence in treatment control SA_3 - SA @ 0.03 (66.79 mm) was recorded higher pod diameter (mm), which was at par with treatment SA_4-SA @ 0.04 (66.79 mm) respectively, rest of the other treatment. The treatment SA_{10}- SA @ 0.1 (59.30 mm) recorded lowest pod diameter (mm)as compare to other treatment, respectively.

The table (Table 1 and Fig. 8) provides data on lethality percent in cowpea cv. Pusa Dharni. The analysis of mean data reveals that the treatment sodium azide 0.01% had the lowest lethality (10.00%), which was comparable to the treatment SA_2 - SA @ 0.02 (13.33%). In contrast, the treatment SA_{10} - SA @ 0.1% concentration recorded the highest lethality (61.67%) among all the treatments. Whereas lethal dose was recorded at sodium azide level SA_7 @0.07% (51.67 %)

after the increase on concentration it had detrimental effect on plant population.

The reason for the changes seen with sodium azide treatment in cowpea can be attributed to its cytotoxic and mutagenic effects. Sodium azide affects various physiological and biochemical processes in plants. Sodium azide contribute to the reductions in growth, delayed flowering, shorter and narrower leaves and pods, and higher lethality in the cowpea plants in a dose-dependent manner. The lower concentrations of sodium azide (0.01 - 0.03%) had relatively minor effects, while the higher concentrations (0.1%) led to severe inhibition of growth and development. The control plants without sodium azide treatment showed optimal growth and yield parameters. The increasing sodium azide concentration beyond 0.03% had an inhibitory effect on growth, yield attributes and viability in cowpea. The 0.03% concentration promoted vegetative growth and yield parameters. The 0.01-0.02% concentrations had minimal effects on germination and viability. These findings highlight the potential of sodium azide to affect the growth and development of cowpea cv. Pusa Dharni. The results obtained in the present study are supported by the works of Lavanya *et al.* (2010); Idress *et al*. (2006), Kulthe *et al.* (2011); Nepolian *et al.* (2019); Mshembula *et al.* (2012).

Table 1: Effect of sodium azide for days to 50% flowering, leaf length, leaf width, pod length, pod width and lethality in cowpea cv. Pusa Dharni.

Tr. No.	Treatments level (%)	Vegetative parameter						
		Germination (%)	Days to 50% flowering	Leaf length (cm)	Leaf width (cm)	Pod length (cm)	Pod diameter (mm)	Lethality (%)
SA_1	SA @ 0.01	90%	46.13	12.67	6.67	22.17	64.20	10.00%
SA_2	SA @ 0.02	87%	45.13	13.20	6.89	23.48	65.57	13.33%
SA_3	SA @ 0.03	83%	43.60	13.23	7.15	23.51	66.90	18.33%
SA_4	SA @ 0.04	78%	48.40	12.33	6.67	21.57	66.79	21.67%
SA_5	SA @ 0.05	73%	51.53	12.00	6.40	21.22	64.39	26.67%
SA_6	SA @ 0.06	53%	52.20	11.40	6.15	21.13	63.94	46.67%
SA_7	SA @ 0.07	48%	56.20	11.35	5.90	20.03	61.53	51.67%
SA_8	SA @ 0.08	45%	56.33	10.36	5.22	17.37	60.96	56.67%
SA_9	SA @ 0.09	43%	58.33	10.00	4.67	16.37	60.25	60.00%
SA_{10}	SA @ 0.1	40%	58.40	10.58	4.28	15.00	59.30	61.67%
SA_{11}	Control	93%	47.93	11.34	6.05	20.92	63.30	36.67%
	SEM±	0.50	1.37	0.48	0.17	0.73	1.76	-
	CD (P=0.05)	1.47	4.06	1.43	0.51	2.15	5.21	-
	CV (%)	6.56	4.65	7.20	5.00	6.25	4.83	-

* Significant at 5 % level

Fig. 1. The seed are soaking in chemical mutagen sodium azide for 4 hours of various concentration.

Fig. 2. Germination test after treatment of sodium azide.

Fig. 3. Leaf width in experimental field.

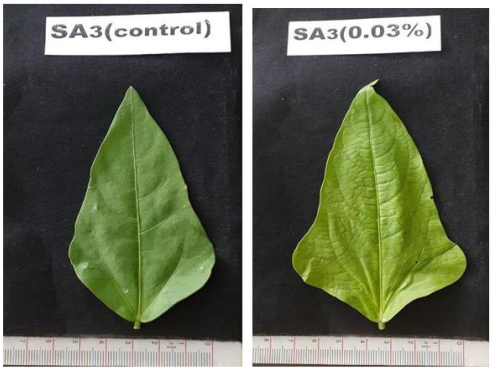

Fig. 4. Mutagenic effect of sodium azide on Leaf width of cowpea.

Fig. 5. Mutagenic effect of sodium azide on Leaf length of cowpea.

Fig. 6. Mutagenic effect of sodium azide on Pod length of cowpea.

Fig. 7. Chlorophyll mutant in M1 generation i.e Viridis, Chlorine and Complex type.

Fig. 7. Experimental field view.

Fig. 8. Mutagenic effect of sodium azide on plant height of cowpea**.**

Fig. 9. Mutagenic effect of sodium azide on Pod Diameter of cowpea.

CONCLUSIONS

In conclusion was found that the control treatment (SA_{11} - Control) performed well in terms of germination percentage, days to 50% flowering, leaf length, leaf width, pod length, and pod diameter in cowpea cv. Pusa Dharni. Among the other treatments, SA_1 - SA @ 0.01 showed comparable performance in terms of germination percentage and lethality, while SA_3 - SA @ 0.03 exhibited early flowering and favorable leaf, pod length, and pod diameter. On the other hand, SA_{10} - SA @ 0.1 showed the lowest germination percentage and highest lethality.

These findings highlight the importance of proper concentration and application of sodium azide in cowpea cultivation. Further research is needed to understand the underlying mechanisms and to optimize the dosage and timing of sodium azide application to maximize desired growth parameters and minimize lethality in cowpea cv. Pusa Dharni.

FUTURE SCOPE

These findings contribute to a better understanding of the potential mutagenic effects of SA on cowpea and highlight the importance of further research for next generation.

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Conflict of Interest. None.

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