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Influence of Foliar Application of Growth Stimulants and Fungicides on Seed Yield and Quality in Soybean

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment imposing foliar sprays of growth regulators and two fungicides at different crop growth stages in two varieties of soybean was conducted during *kharif 2022* to identify appropriate prophylactic measures to combat the seed damages during developmental stages so as to reduce seed deterioration and thereby improve the longevity of seed at College Farm, College of Agriculture, Rajendranagar. Seed quality data was recorded. The laboratory studies under storage were conducted in FCRD with two replications and observations on various seed quality traits *viz.* germination (%), seedling dry weight (mg) seedling vigour index and field emergence (%) . Among the various treatments T6 *viz*. Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity showed superior performance for yield, yield attributes and seed quality.

Keywords: Soybean; foliar sprays; germination; field emergence and seedling vigour index.

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1. INTRODUCTION

Soybean (*Glycine max* L.Merill) being a pulse and oilseed crop occupies an important place in world's agrisector, due to its high productivity, ease in cultivation with high profitability. It contributes to about 25% of the global vegetable oil production and to two thirds of the world's protein in livestock feeding. In India, it is cultivated in an area of 11.98 million hectares with a production of 11.88 Million tonnes and productivity of 991 kg ha^{-1} [1]. The crop has gained importance during past few years in the state of Telangana o ccupying an area of 3.48 lakh ha with a productionof 3.54 lakh tonnes and productivity of 1015 kg ha^{-1} [1]. Low seed viability coupled with low seed multiplication ratio and high seed requirement is a major bottleneck in soybean cultivation.

The major constraint in soybean cultivation in tropics is acute shortage of quality seed due rapid loss of vigour and germination in storage. Loss of germination is more acute in tropical countries Pascal and Ellis, [2] as compared to temperate environment. The causes for seed deterioration include loss in membrane integrity, reduction in activity of antioxidant enzymes leading to development of ROS and thereby affecting the seed longevity.

The major factors controlling seed quality include plant growth and post harvest handling of the seed.The application of growth regulators and salicylic acid at non-toxic concentration regulates biotic and abiotic stress tolerance in plants Xu and Tian, [3]. Further seed treatment with appropriate chemicals and invigorants will not only protect them from pathogens under storage but will also help in combating deterioration under storage.

The loss in seed quality during storage leads to disruption in seed multiplication chain especially during breeder and foundation stage of seed production. Therefore, to improve production processes it is necessary to identify an appropriate package at pre & post harvest stages to combat deteriorative changes to improve seed longevity. The current study was taken up to identify appropriate prophylactic measures to combat the seed damages during developmental stages so as to reduce seed deterioration under storage and improve the longevity of seed.

2. MATERIALS AND METHODS

2.1 Field Experiment

The experiment was conducted at College Farm, Rajendranagar, Hyderabad during rainy season, 2022 in two factorial randomised block design replicated twice. The treatments comprised of two varieties i.e JS 335 and Basar as main plots and seven foliar applications comprising of growth regulators and fungicides as sub plots. The details of foliar sprays are as detailed below.

T1: Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)
T2: Dormalinflowering @ 1 kg/acre (50 DAS)
T3: Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)
T4: Salicylic acid@ 50ppm at flowering (40 DAS) and pod filling stages (60 DAS)
T5: Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at pod formation, seed development and seed maturity
T6: Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity
T7: Control

Each variety was sown in a net plot size of 12 m^2 at 30 cm spacing between the rows and 10 cm between the plants. The recommended dose of N, P and K were applied @ 30 : 60 : 40 kg ha^{-1}. The entire phosphorous and potassium and half the dose of nitrogen were applied as basal, while remaining nitrogen is applied at 30 days after sowing. Intercultural operations and irrigation schedules were followed as and when necessary. Need based plant protection measures were adopted to raise a healthy crop. The data of following parameters was recorded.

2.2 Growth, Yield and Yield Attributes

Days to 50% flowering: The number of days taken from the date of sowing to the emergence of flowers in 50% of the plants was recorded.

Number of pods per plant: The total number of pods in randomly selected five plants $plot^{-1}$at the time of maturity was counted and average of it is expressed as number of pods per plant.

Plant dry weight (g): The five individual plants was harvested and dry weight of it was collected. The average weight of five plants is expressed as plant dry weight (g).

Grain yield per plant (kg): The crop was harvested when pods were matured. The harvested crop was sundried, threshed in a multi-crop thresher and plot yield was determined after drying the seed to safe moisture limits.

100 Seed weight (g): A random of two samples of 100 seeds from each replication of each treatment were recorded for weight and averaged to derive 100seed weight in grams.

2.3 Seed Parameters

2.3.1 Seed storage

The seed harvested and dried to safe moisture limits is kept for storage in gunny bags under ambient conditions at Dept. of Seed Science and Technology, Seed Research and technology Centre, Rajendranagar for a period of six months and the data of following seed quality parameters was recorded at bimonthly intervals:

Seed Moisture (%): The seed Moisture was estimated as per ISTA [4] rules by placing five grams of grounded sample into aluminium box in two replicates and dried at 103^{o}C for 17 hours in hot air oven. The percent moisture content was calculated by using the formula:

Moisture content (%) = W2 - W3 / W2 - W1 × 100

W_1 - Weight of the empty container along with lid (gm)

W_2 - Weight of the container along with lid and grounded seed sample before drying (gm)

W_3 - Weight of the container along with lid and grounded seed sample after drying (gm)

Germination (%): The percent seed germination was estimated as per ISTA [4] using between paper method. Fifty seeds of eight replicates were placed for germination and kept in the germination chamber at temperature of 25**±** 1^{o}C and RH of 95 % and percent germination was calculated as follows.

Germination percentage % = Number of normal seedlings / Total number of seeds planted × 100

Seedling dry weight (g): Ten randomly selected seedlings from germination test were oven dried at 100^{0}Cfor 24 hrs and seedling dry weight was expressed in milligrams.

Seedling vigour index: Seedling vigour index was calculated as per procedure given by Abdul-Baki and Anderson [5] and expressed in whole number.

SVI = Germination (%) × Seedling dry weight (mg)

Field emergence (%): The field emergence test was conducted by sowing hundred seeds from each treatment in two replications and evaluated on eighth day and expressed as percentage.

Field emergence (%) = Number of seeds germinated on eighth day / Total number of seeds sown ×100

2.4 Statistical Analysis

The data recorded were tabulated and analyzed statistically using Fischer's analysis of variance technique and least significant difference (LSD) test at 5% probability level was applied to compare differences among treatment mean [6].

3. RESULTS AND DISCUSSION

Soybean seed with its fragile seed coat is subjected to field weathering and mechanical damage during post-harvest operations especially in tropics leading to loss in viability in a short period of storage. The current study using various growth regulators and fungicides as foliar sprays at various growth stages was taken up to identify their possible role in combating seed losses under storage and maintain their viability for longer periods.

3.1 Effect of Foliar Sprays of PGRs and Fungicides on Growth, Yield and Yield Attributes

The data on growth, yield and its attributes in soybean (*Glycine max*) as influenced by foliar application of growth regulators and fungicides during different growth stages is presented in Table 1. A significant variation among the varieties was observed for days to 50% flowering, no. of pods/plant, and test weight, while among the treatments for pods/plant, plant dry weight and yield per plot. A significant variation was observed only for plant dry weight among the interaction of varieties and treatments.

Table 1. Influence of foliar srays of growth regulators and fungicides on yield and yield attributes in soybean

Varieties / Foliar sprays	Days to 50 % flowering			No. of plants/plot			Plant dry weight (g)			Test weight (g)			Yield / plot (Kg)		
	JS 335	Basara	Mean	JS 335	Basara	Mean	JS 335	Basara	Mean	JS 335	Basara	Mean	JS 335	Basara	Mean
T1	42.0	47.5	44.75	65.0	67.0	66.00	10.362	11.167	10.764	11.465	11.925	11.695	2.35	2.25	2.30
T2	42.5	47.5	45.00	57.0	74.5	65.75	10.043	9.951	9.997	11.905	12.050	11.977	1.95	2.60	2.27
T3	42.5	48.0	45.25	61.5	71.5	66.50	14.129	11.568	12.849	11.705	12.055	11.880	2.30	2.70	2.50
T4	42.5	48.5	45.50	68.0	73.0	70.50	14.248	10.555	12.401	11.275	11.955	11.615	2.60	2.95	2.77
T5	42.5	47.5	45.00	61.0	65.5	63.25	12.702	11.818	12.260	11.610	12.305	11.958	2.65	2.65	2.65
T6	42.0	47.0	44.50	70.5	89.5	80.00	11.486	12.624	12.055	10.910	11.805	11.358	3.17	3.15	3.16
T7	43.00	48.00	45.50	54.0	53.0	53.50	8.188	9.153	8.671	11.005	11.555	11.280	2.20	1.90	2.05
Mean	42.43	47.71		62.4	70.6		11.59	10.98		11.41	11.95		2.46	2.60	
	V	T	VX T	V	T	VX T	V	T	VX T	V	T	VX T	V	T	VX T
CD (5%)	0.612	NS	NS	5.881	11.003	NS	NS	1.391	1.968	0.414	NS	NS	NS	0.633	NS
SE(m)	0.202	0.377	0.534	1.939	3.627	5.130	0.245	0.458	0.648	0.136	0.255	0.361	0.111	0.209	0.295
G.MEAN	45.07			66.55			11.680			11.680					
CV%	1.677			10.911			4.382			4.382					

V- Varieties, T- Foliar sprays

T1- Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)

T2- Dormalinflowering @ 1 kg/acre (50 DAS)

T3 - Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)

T4 - Salicylic acid@ 50ppm at flowering (40 DAS) and pod filling stages (60 DAS)

T5 - Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at pod formation, seed development and seed maturity

T6 - Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity

T7 - Control

Among the varieties JS 335 showed early flowering compared to Basar, while foliar sprays had no impact on days to 50% flowering. Number of pods per plant was significantly higher for treatment T6 i.e foliar spray of Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity and lowest in control for both the varieties. The variety JS 335 for treatment T4 i.e foliar sprays of Salicylic acid showed significantly higher plant dry weight, while lowest plant dry weight was observed in control for both the varieties. Among the varieties a significantly higher test weight was recorded for variety Basar.

A significantly higher seed yield for treatment T6 was recorded in both the varieties over other foliar sprays. Foliar application with relative low concentration of antioxidant promoted and influenced the growth, development, differentiation of plants and enhanced the plant growth, seed yield parameters Siamak *et al*., [7]. Kuchlan *et al*., [8] identified that foliar application of α- tocopherol, K_2HPO_4 and salicylic acid in soybean recorded superior yields along with superior seed quality. The growth regulators generally enhance the plant growth with good assimilation and translocation of nutrients and photoassimilates to the economic parts of the plant [9]. The foliar sprays with fungicides recorded higher number of pods per plant due to less damage or lower number of infested pods.

3.2 Effect of Foliar Sprays of PGRs and Fungicides on Seed Quality Parameters in Storage

The impact of varieties and foliar sprays on various seed quality parameters is presented in Fig 1. The germination percentage and seedling vigour index of T5 and T6 were highest in JS 335 and Basara respectively at 0 months of storage, while after six months of storage highest germination and seedling vigour index was observed in T6 i.e Pyraclostrobin + Thiophonate in Basara and in T4 in JS 335 both the varieties. Highest per cent field emergence was recorded for treatment T6 i.e Pyraclostrobin + Thiophonate at initial and six months of storage in both the varieties, while lowest field emergence after storage was recorded in T3 and T5 in JS 335 and in T7 in Basara.

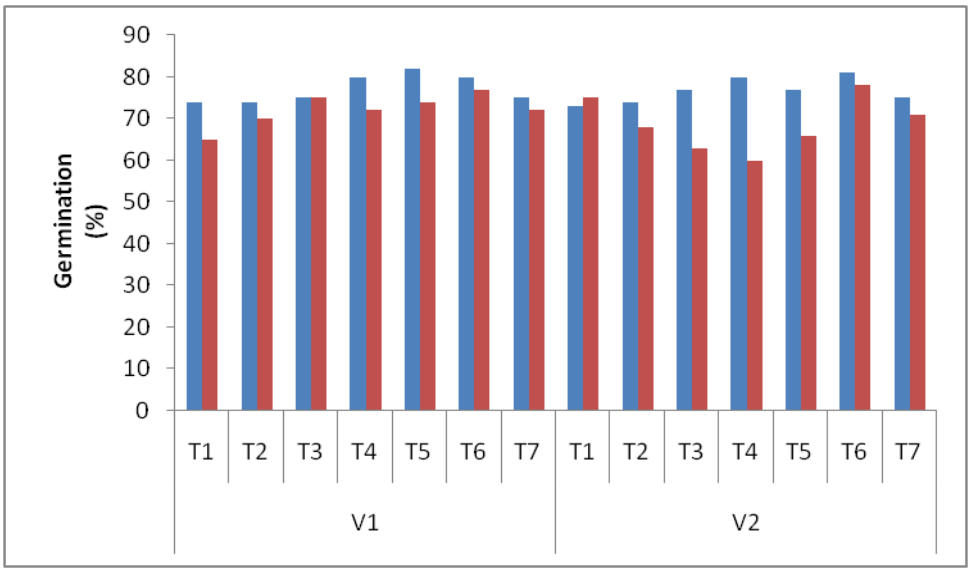

Fig. 1. Influence of foliar srays of growth regulators and fungicides on seed germination in soybean

V1- JS 335, V2- Basara

T1- Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)

T2- Dormalinflowering @ 1 kg/acre (50 DAS)

T3 - Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)

T4 - Salicylic acid@ 50ppm at flowering (40 DAS) and pod filling stages (60 DAS)

T5 - Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at pod formation, seed development and seed maturity

T6 - Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity

T7 - Control

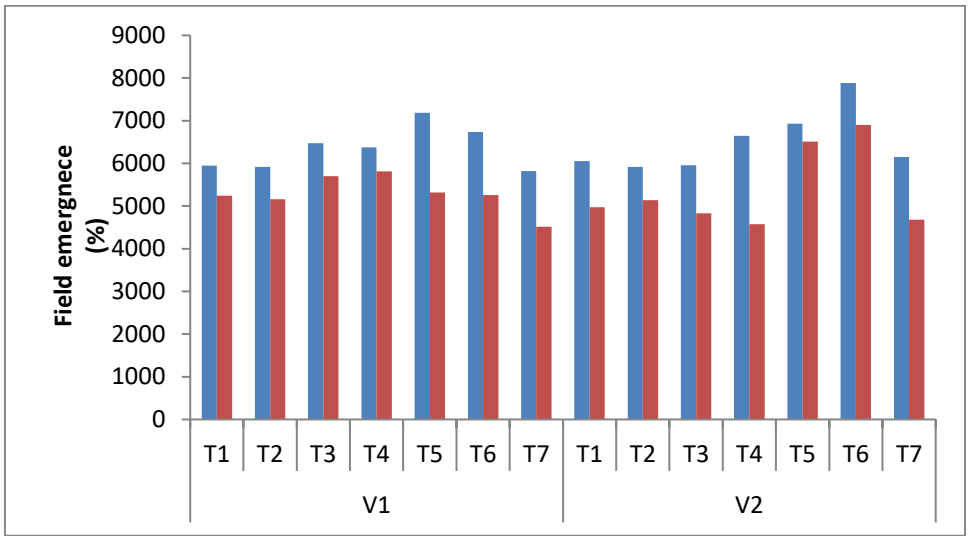

Fig. 2. Influence of foliar srays of growth regulators and fungicides on Field emergence in soybean

V1- JS 335, V2- Basara
T1- Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)
T2- Dormalinflowering @ 1 kg/acre (50 DAS)
T3 - Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)
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T6 - Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity
T7 - Control

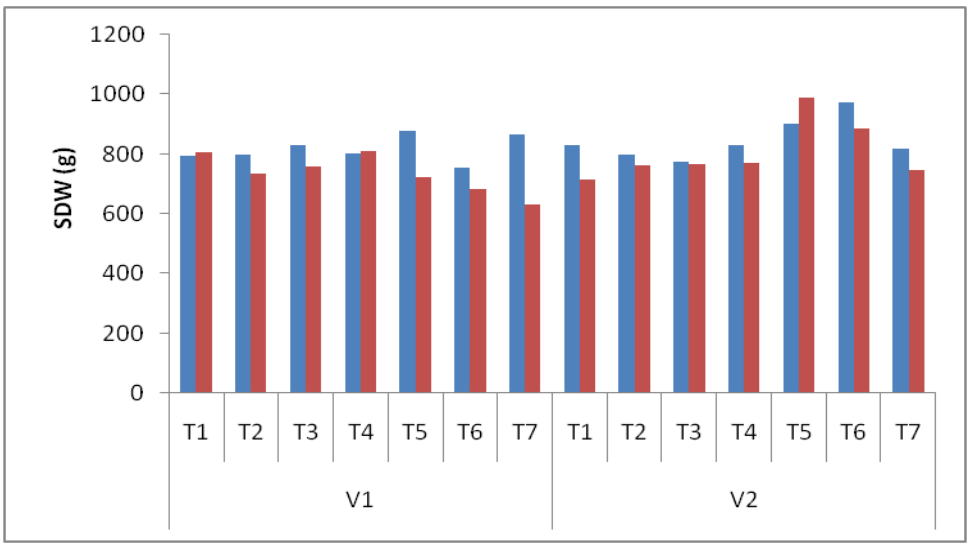

Fig. 3. Influence of foliar srays of growth regulators and fungicides on seed dry weight (SDW) (mg) in soybean

V1- JS 335, V2- Basara
T1- Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)
T2- Dormalinflowering @ 1 kg/acre (50 DAS)
T3 - Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)
T4 - Salicylic acid@ 50ppm at flowering (40 DAS) and pod filling stages (60 DAS)
T5 - Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at pod formation, seed development and seed maturity
T6 - Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity
T7 - Control

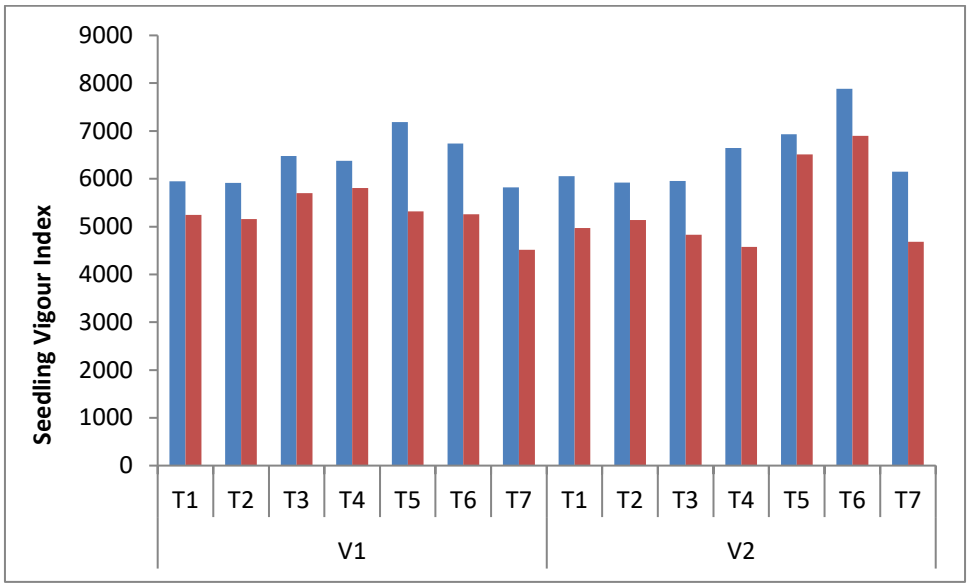

Fig. 4. Influence of foliar sprays of growth regulators and fungicides on seedling Vigour Index in soybean

V1- JS 335, V2- Basara
T1- Akre shield @ 1ml/l (20-30 DAS) + Dormalin Vegetative @ 1.5 kg/acre (40 DAS) + Dormalin flowering @ 1 kg/acre (50 DAS)
T2- Dormalinflowering @ 1 kg/acre (50 DAS)
T3 - Agroplus @100g/acre (20 DAS) + More yield @100 g/acre (30 DAS)
T4 - Salicylic acid@ 50ppm at flowering (40 DAS) and pod filling stages (60 DAS)
T5 - Pyraclostrobin + Metiram (Cabriotop) @ 2g/l at pod formation, seed development and seed maturity
T6 - Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity
T7 - Control

Suraj *et al*., [10] identified that pre harvest phytosanitary spray of nativo showed highest germination percentage and seedling vigour indices I and II in soybean. The higher germination rate under fungicidal sprays can be attributed to reduced fungal infection and better seed health. Soto-Arias and Munkvold [11] observed a reduced rate of *Phomopsis* spp seed infection in foliar spray of pyraclostrobin and tebuconazole but had no impact on seed vigour and germination. Cochran *et al*., [12] identified that foliar application of azoxystrobin at R5 stage increased the germination under accelerated ageing. This enhanced vigour under fungicidal sprays clearly indicates the role of seed infections in seed deterioration in soybean. Salicylic acid (SA) treatment stimulates flowering and grain set. Induction of defense related proteins in salicylic acid treated finger millet plants may play a role in disease resistance [13].

4. CONCLUSION

Among the various treatments T6 *viz*. Pyraclostrobin + Thiophonate (Xelora) @ 2 ml/l at pod formation, seed development and seed maturity showed superior performance for yield, yield attributes and seed quality. The treatments T5 and T4 showed on par performance with T6 indicating that seed infections are major hindrances of seed quality under storage in soybean indicating the need to identify appropriate measures to combat infection and improve seed quality under storage.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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