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Influence of endophytes on seed quality in heat resilient maize hybrid/RCRMH-2 seed production

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Abstract

The laboratory experiment was conducted to study the influence of endophytes on seed quality in heat-resilient maize hybrid RCRMH-2 seed production at the Department of Seed Science and Technology, College of Agriculture, Raichur. University of Agricultural Sciences, Raichur, during Rabi 2024-25. The experiment was laid out in Factorial Complete Randomized Design (FCRD) with four replications and twelve treatments. The first factor consisted of endophytes (P) viz., *Beauveria bassiana* (P₁), *Metarhizium anisopliae* (P₂), *Bacillus subtilis* (P₃) and second factor consisted of methods of application (M) viz., (M₁): seed treatment, (M₂): seed priming, (M₃): foliar spray and (M₄): drenching. Among all treatments, P₂M₁ (*Metarhizium anisopliae* via seed treatment) recorded significantly higher seed germination percentage (99.50%), seedling length (30.86 cm), seedling dry weight (2.54 g), seedling vigour index-I (3071), seedling vigour index-II (252) over the remaining treatments and was followed by P₂M₂ (*Metarhizium anisopliae* via priming). The study indicated that the application of P₂M₁ (*Metarhizium anisopliae* via seed treatment) at 20 g kg⁻¹ enhances seed quality and helps to increase the economic status of seed growers.

Keywords: Seed quality, *Metarhizium anisopliae*, seed treatment, priming, heat-resilient hybrid

Introduction

Crops are colonized by complex microbial communities (Hardoim *et al.*, 2015) ^[10], and some of them are detrimental and cause diseases, whereas others promote plant growth and enhance nutrient acquisition and tolerance to biotic and abiotic stresses via a multitude of mechanisms (Brader *et al.*) ^[3]. The fungi or bacteria which grow inside the plant tissue without causing any harm to the host are termed as endophytes. Endophytes are endosymbionts that are integral components of a plant micro-ecosystem, which is associated with the plant throughout its life cycle without inducing any disease. They perform symbiotic functions, including production of secondary metabolites or synthesis of signalling molecules that function as both internal and external stimuli during mutualistic interactions (Tidke *et al.*, 2018) ^[19]. Endophytes produces various plant growth hormones viz., auxin, abscisic acid, ethylene, GA₃, IAA, enzymes and biologically active metabolites which help augment the host betterment.

Maize is the only food cereal that can be grown in diverse seasons, ecologies and uses, because of potential market and lower risk involved in the production. To meet the demand of the seed requirement the private and public sectors have introduced their hybrids. As a public sector organization, the University of Agricultural Sciences, Raichur has developed maize hybrid (RCRMH-2) and released it for general cultivation in Karnataka. RCRMH-2 is heat stress resilient hybrid and multiple disease resistant.

Recent studies predicted that world population may reach 8.6 billion by 2030 (www. India budget. gov.in) such an increasing human population places pressure on agriculture. There is a need to always meet the increasing demand. To feed this population with quality and to run industries, an increase in production is needed. On the other side, today's agriculture is becoming input- intensive with more reliance on synthetic fertilizers and agrochemicals to fulfill the feed demand of the growing numbers. (Lin *et al.*, 2019) ^[13]. In this scenario, the use of beneficial endophytic microbes as an enchanting strategy to overcome the use of synthetic and chemical products.

The present study aims to explore the potential ability of a few selected endophytic fungi in modulating seed quality parameters under laboratory conditions. The reason behind the use of endophytes is to maintain a safe environment. These are the promising agents that promote their host growth even in stressed environments. Today these endophytic bacteria grab the attention, because these are the potential source of sustainable agriculture (Fiore *et al.*,1995) [7] and prevents the growing population of the world from future hazards in agriculture.

Materials and Methods

Collection of experimental materials

The freshly harvested maize hybrid RCRMH-2 seeds produced during rabi season to evaluate the effect of endophytes on seed yield and its parameters (Pallavi *et al.*, 2025) were used in this experiment as seed source to evaluate the seed quality parameters.

Laboratory experiment

The laboratory experiment was carried out with 12 treatments replicated four in a Factorial Complete Randomized Design (FCRD) during rabi season of 2024-25 at the Department of Seed Science and Technology, College of Agriculture, Raichur, Karnataka. The first factor consists Endophytes (P) viz., *Beauveria bassiana* at 5% (P₁), *Metarhizium anisopliae* at 5% (P₂), *Bacillus subtilis* at 8% (P₃) and second factor consists methods of application (M) viz., M₁: Seed treatment 20 g kg⁻¹ of seed, M₂: Seed priming for 12 hrs duration with a solution ratio of 1:1, M₃: Foliar spray at 30 and 45 days and M₄: drenching at 30 and 45 days.

Evaluation of seed quality parameters

Seed germination (%)

One hundred seeds in four replications were drawn at random from each treatment, and the germination test was conducted using the between paper (BP) method as per ISTA (Anon., 2024). The rolled towels were incubated in a germination chamber maintained at 25 ± 2°C temperature and 90 ± 5 per cent relative humidity. The germinated Seedlings were evaluated on the seventh day at the final count and seed germination was expressed based on normal Seedlings.

Seed germination(%)= $\frac{\text{Number of normal seedlings}}{\text{Number of seeds used for the test}} \times 100$

Seedling length (cm)

During the final count, ten normal seedlings will be selected at random from each treatment andreplication. The seedling length was measured from the tip of the longest root and growing meristematic tip of shoot and expressed in centimeter.

Seedling dry weight (g 10 seedlings⁻¹)

Ten seedlings used for measuring the shoot and root length were kept in butter paper covers and dried in a hot air oven at 70 °C ± 2°C for 24 hours. Then the butter paper bags were removed and cooled in desiccators for 30 minutes and weighed on an electronic balance and expressed in grams.

Seedling Vigour Index

Seedling index was calculated as per the formula given by Abdul Baki and Anderson (1973) [1] expressed as a whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm).

Seedling vigour index-II = Germination (%) x Mean seedling dry weight (g).

Statistical analysis

The data obtained from the experiment were statistically analysed by adopting appropriate statistical methods as outlined by Panse and Sukhatme (1985) [16]. The critical difference (CD) values were calculated and treatments means were compared at 1 per cent for laboratory observation.

Results and Discussion

The results pertaining to seed quality parameters viz., germination percentage, seedling length, seedling dry weight, seedling vigour index-I, seedling vigour index-II of the maize hybrid (RCRMH-2) were found to be significant due to the effect of endophytes and its application methods (Table 1). Among the different treatments imposed application of *Metarhizium anisopliae* via as seed treatment (P₂M₁) recorded significantly highest germination percentage (99.50%), seedling length (30.86 cm), seedling dry weight (2.54 g), seedling vigour index-I (3071), seedling vigour index-II (252), followed by *Metarhizium anisopliae* applied as priming (P₂M₂). The probable reason may be seed treatment with beneficial endophytes during the parental plant's life cycle results in vertical transmission of these microbes to the next generation of seeds, leading to significantly enhanced seed quality parameters. Where the endophytes effectively colonize the reproductive tissues (flowers, ovules, pollen) of the parent plant and are passed directly into the developing seeds. This ensures that the next generation of seedlings is immediately inoculated with beneficial microbes upon germination, by these endophytes produce phytohormones (like auxins and gibberellins) and enzymes (like α -amylase) that promote cell division, elongation, and the breakdown of stored nutrients, providing the seedling with a strong start. giving them a significant competitive advantage from the earliest stages of life (Maiwenn and Robin., 2021). In contrast *Bacillus subtilis* applied as foliar spray (P₃M₃) recorded minimum germination percentage (89.00%), seedling length (19.07 cm), seedling dry weight (1.97 g), seedling vigour index-I (1697), seedling vigour index-II (175). So taken together, these effects make *Metarhizium anisopliae* an effective, eco-friendly seed treatment that boosts seed quality sustainably. (Rivas-Franco *et al.*, 2020) [17]. Similar result found by Lastochkina *et al.*, 2020 [12] in wheat, Espinoza *et al.*, 2019 [6] in chilli, Gayathri *et al.*, 2020 [8] in maize, Chowdhury *et al.*, 2024 [4] in wheat, Elena *et al.*, 2011 [5] in tomato, Theertha *et al.*, 2023 [18] in cowpea.

Table 1: Effect of endophytes and method of application on germination percentage, seedling length and dry weight of maize hybrid RCRMH-2

Treatments	Germination percentage				Seedling length(cm)				Seedling dry weight (g 10 ⁻¹)				Seedling vigour index –I				Seedling vigour index –II			
	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean	P ₁	P ₂	P ₃	Mean
M ₁	98.07	99.50	96.76	98.11	28.33	30.86	23.58	27.59	2.42	2.54	2.21	2.39	2778	3071	2281	2710	237	252	213	234
M ₂	97.82	98.27	97.05	97.71	25.03	29.32	23.67	26.00	2.29	2.47	2.28	2.35	2448	2881	2297	2542	224	242	221	229
M ₃	96.20	95.47	89.00	93.55	23.10	22.79	19.07	21.65	2.19	2.13	1.97	2.10	2222	2175	1697	2031	210	203	175	196
M ₄	90.75	92.74	93.84	92.44	19.57	19.87	21.93	20.45	2.00	2.02	2.11	2.04	1775	1842	2057	1892	181	187	198	188
Mean	95.71	96.49	94.16		24.00	25.71	22.06		2.23	2.29	2.14		2306	2492	2083		213	221	202	

	S.Em. ±	CD @ 1 %	S.Em. ±	CD @ 1 %	S.Em. ±	CD @ 1 %	S.Em. ±	CD @ 1 %	S.Em. ±	CD @ 1 %
P	0.38	1.10	0.32	0.94	0.02	0.07	29.36	84.56	2.65	7.64
M	0.44	1.28	0.37	1.09	0.03	0.08	33.90	97.65	3.06	8.82
P x M	0.77	2.21	0.65	1.89	0.05	0.15	58.73	169.13	5.30	15.28

Legend: Factor –I Endophytes (P)					Factor-II Method of application (M)				
P ₁ :	<i>Beauveria bassiana</i> @ 5%				M ₁ :	Seed treatment			
P ₂ :	<i>Metarhizium anisopliae</i> @ 5%				M ₂ :	Seed priming			
P ₃ :	<i>Bacillus subtilis</i> @ 8%				M ₃ :	Foliar spray			
					M ₄ :	Drenching			

Conclusion

Based on experimental results, it was concluded that application of 20 g /kg *Metarhizium anisopliae* via as seed treatment recorded higher seed quality attributing parameters of hybrid maize. The results affirm that endophytes enhances seed early seedling establishment through improved phytohormone activity, nutrient mobilisation so that seed producers may get good quality seeds than other treatments. It can be recommended as a practical, eco-friendly technology for augmenting productivity and sustainability in seed production.

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