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### STANDARDIZATION OF SEED TREATMENT AND POTTING MIXTURE FOR PRODUCTION OF TOMATO SEEDLINGS IN PORTRAY NURSERY

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#### ABSTRACT

Studies were conducted with tomato  $cv.CO_3$  on evaluation of seed and nursery management techniques for production of elite seedlings for transplanting. Studies on individual performance of seed fortification technique, seed coating technique, media and biocontrol agents and biofertilizers for portray nursery and their combination of the best revealed that seed designed as  $ZnSO_4$  (1%) priming and coated with pink polymer (3%) along with pesticides *viz.*, bavistin @ 2g+ imidachloprid (1ml) and sown in portrays filled with mixture of vermicompost + coirpith (in equal volume) and added with pseudomonas + Azophos @ 10g per kg of seed produced elite seedlings which had 19% and 16.5% higher germination and biomass production.

**KEYWORDS:** seedlings, priming, pesticides, germination.

#### INTRODUCTION

Tomato (Lycopersicon esculentum Mill.) is widely grown vegetable crop in the world. The economics of this crop spreads throughout the world as it is widely used for fresh consumption and also processed for vegetable food industry. However, the productivity of tomato in India is very low (14.07 t ha-1) as compared to USA 73.87 t ha-. India's tomato productivity was lower than the world tomato productivity (27.47 t ha-1). One of the causes for lower productivity of tomato is identified as use of poor quality seed. Tomato, on the other hand is an annual crop, where the seeds are small with the 100 seed weight of 3g and are normally raised in the nursery and transplanted to the main field (Ilyas, 1994). Hence for production of quality seedling for main field transplanting adoption of seed treatment and nursery management techniques are warranted. In modern era, the seedling production has been developed as micro industry, where seedlings are raised in portrays and is directly transplanted to the main field, which necessitates the selection of media for root development and easy prickable nature in handling portrays for seedling production. Hence studies were made on identification of suitable seed treatment and enriched nursery media for portrays for production of quality seedlings. (Ilyas and Suartini, 1998) Yunitasari and Ilyas, (1994) also reported that seed treatment and selection of nursery media are important in management of tomato nursery.

#### **MATERIALS & METHODS**

Fresh seeds of tomato cv.CO3 with higher germination in line with certification standard were obtained from seed orchard of Tamil Nadu Agricultural University. The seeds were individually fortified with different inorganic nutrients / regulants *viz.*, GA<sub>3</sub> (100 and 200ppm), KNO<sub>3</sub> (1and 2%), KH<sub>2</sub>PO<sub>4</sub> (1 and 2%) and ZnSO<sub>4</sub> (1and 2) in

two different concentrations in two different durations using seed solution ratio of 1:1, for a duration of 8 and 16h. The seeds fortified were dried to original moisture content, and were evaluated for germination (ISTA, 2007), root and shoot length, dry matter production and vigour index (Abdul baki and Anderson, 1973). From the evaluated concentration of fortifying agents, seeds were fortified and film coated with pink polymer (3g/kg of seed) enriched with bavistin (2g/kg of seed) and imidachloprid (1ml per kg of seed) and evaluated for seed quality characters as expressed earlier. On the other hand, control seeds were germinated in different nursery media (vermi compost, coir pith, poultry manure, goat manure and FYM) and their combinations (Vermi compost +Coir pith, Vermi compost + Goat manure, Vermi compost + FYM, Vermi compost + Poultry manure, Coir pith + Goat manure, Coir pith + Poultry manure, Coir pith +FYM, Poultry manure + Goat manure, FYM+ Goat manure, FYM+ Poultry manure) in shade net condition. Based on germination and seedling growth characters the best media was selected (Vermicompost +Coir pith). Then the media along with normal nursery mixture (sand + soil + FYM in 1:1:1 ratio) was enriched with different combinations of biofertilizers and biocontrol agents (Azospirillum, Phospho Bacteria and Pseudomonas fluorescens) as additive inoculants @ 10g/kg of media and the best enriched combination of bio products was selected by germinating the control seeds. Then, the seeds fortified with GA<sub>3</sub> (200 ppm), KNO<sub>3</sub> (1%), KH<sub>2</sub>PO<sub>4</sub> (1%) and  $ZnSO_4$  (1%) were coated with polymer enriched with pesticides and were sown in the portrays filled with selected media that was enriched with bio regulants. The seeds were allowed to grow up in the nursery for a period of 21days and were evaluated for seed germination, seedling length and dry matter production. The data were analyzed as per panse and sukhathme (1997).

#### **RESULTS & DISCUSSION**

## Influence of seed fortification treatment on seed quality characters

Highly significant results were obtained with the evaluated parameters (germination, root length, shoot length and vigour index) for the seed fortification treatments. The seeds fortified with with  $KNO_3$  1% and  $ZNSO_4$  1% with 8h soaking duration recorded the highest germination percentage (96%), which was 165 higher than control (80%). At 16h soaking duration,  $ZNSO_4$  1% recorded the

highest value (94%), while  $GA_3$  the lowest (84%) percentage.

Irrespective of soaking duration the seeds soaked in  $ZNSO_4$ 1%, followed by  $KH_2PO_4$  1% recorded higher seedling quality characters, while the shortest (12.64 cm) was with seeds fortified with  $GA_3$  1%.  $ZNSO_4$  1% seed fortification also recorded significantly higher dry matter production while it was the lowest in control. Computed vigour index values were also higher with  $ZNSO_4$  1% seed fortification (Table1).

**TABLE 1**. Influence of seed priming on seed germination percentage, root length, shoot length, dry matter production and vigour index

Treatment	Germin	ation %	Root (c	length m)	Sh leng	noot th(cm)	Dry I Produ seedlin	Matter ction10 ng <sup>-1</sup> (g)	V i	'igour ndex
	Soaking duration in hours with equal volur					ual volum	ne of seed to solution ratio			
	8h	12h	8h	12h	8h	12h	8h	12h	8h	12h
Control	80 (63.44)	80 (63.44)	12.43	12.51	5.25	5.16	0.0104	0.0102	1414	1412
GA <sub>3</sub> 100ppm	84 (66.42)	86 (68.03)	12.84	12.64	6.23	5.93	0.0113	0.0106	1677	1597
GA3 200ppm	90 (71.57)	86 (68.03)	13.41	13.28	6.42	6.17	0.0117	0.0109	1784	1672
KNO3 1%	84 (66.42)	84 (66.42)	13.57	13.35	6.65	6.25	0.0122	0.0117	1981	1842
KNO3 2%	84 (66.42)	88 (69.73)	12.95	12.76	6.52	6.07	0.0119	0.0111	1830	1657
KH2PO4 1%	84 (66.42)	90 (71.57)	13.62	13.47	6.78	6.34	0.0124	0.0121	1917	1782
KH2PO4 2%	88 (69.73)	84 (66.42)	13.23	13.14	6.62	6.12	0.0120	0.0119	1786	1617
ZNSO4 1%	90 (71.57)	90 (71.57)	13.94	13.62	7.93	6.49	0.0135	0.0126	2100	1850
ZNSO4 2%	88 (69.73)	88 (69.73)	13.44	13.31	7.21	6.22	0.0132	0.0121	1941	1758
Mean	86 (68.03)	85 (67.22)	13.27	13.12	6.62	6.08	0.0121	0.0115	1826	1687
SEd	2.867	5.375	0.106	0.111	0.193	0.212	0.007	0.008	65.669	108.757
CD	6.612	12.395	0.244	0.263	0.451	0.489	0.0016	0.0018	151.432	250.796

#### Influence of seed priming cum enriched polymer coating on seed quality characters.

Seeds designed with fortification and coating treatment, revealed that seed treated with  $ZNSO_4 \ 1\% + Carbendazim$ + Imidachloprid+ polycoat (93%)followed by  $KH_2PO_4$ 1% + Carbendazim + Imidachloprid + Polycoat (90.67%)and the minimum (82.67%) was by control seeds. Among the treatments maximum seedling characters and vigour index values were (2137) recorded for seed treated with ZNSO<sub>4</sub> 1% + Carbendazim + Imidachloprid + polycoat followed by KH<sub>2</sub>PO<sub>4</sub> 1% + Carbendazim + Imidachloprid + Polycoat (2027) and the minimum (1634) was with control (Table 2).

TABLE 2. Influence of seed fortification and	polymer	coating on	seed quality
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Treatment	Germination %	Root length (cm)	Shoot length (cm)	Dry Matter Production 10 seedling <sup>-1</sup> (g)	Vigour index
Control + Carbendazim + Imidachloprid + Polycoat	83 (65.65)	12.91	5.85	0.0102	1634
GA <sub>3</sub> 200ppm Carbendazim + Imidachloprid + Polycoat	85 (67.22)	13.38	6.72	0.0114	1801
KNO <sub>3</sub> 1%+ Carbendazim + Imidachloprid + Polycoat	87 (68.87)	13.97	7.12	0.0121	1901
KH <sub>2</sub> PO <sub>4</sub> 1% + Carbendazim + Imidachloprid + Polycoat	91 (72.55)	13.92	7.44	0.0127	2027
ZNSO <sub>4</sub> 1% + Carbendazim + Imidachloprid + Polycoat	93 (74.66)	14.13	7.76	0.0134	2137
Mean	88 (69.73)	13.66	6.98	0.0120	1900
SEd	2.066	0.202	0.124	0.0005	53.376
CD	4.763	0.466	0.286	0.0011	123.086

**Influence of organic manures on seed quality characters** Among the manures and their combinations, the higher germination percentage (95.24%) was recorded with seed sown in Vermi compost +Coir pith and followed by Vermi compost + Poultry manure and Coir pith + Poultry manure (90.48%) and the minimum (71.90%) was with FYM. Within the manures, longer root length (8.64 cm) was observed in Vermi compost +Coir pith and followed by Coir pith + Poultry manure (8.36 cm) and lowest root length (6.39 cm) with FYM. Among the treatments in manures, Vermi compost + Poultry manure recorded the maximum value for shoot length (7.66 cm), followed by Vermi compost +Coir pith (7.34 cm) The Vermi compost +Coir pith combination also recorded significantly higher dry matter production (0.0142 g) and the vigour index (1522) (Table 3).

TABLE 5. Influence of organic manufes on seed quanty enaracters							
	Germination	Root	Shoot	Dry Matter	Vigour		
Treatment	%	length	length	Production10	index		
	/0	(cm)	(cm)	seedling <sup>-1</sup> (g)	mucx		
Vermi compost	79 (62.73)	7.63	6.52	0.0104	1118		
Vermi compost +Coir pith	84 (66.42)	8.64	7.34	0.0142	1342		
Vermi compost + Goat manure	76 (60.67)	7.81	6.46	0.0112	1085		
Vermi compost +fym	74 (59.35)	7.22	6.23	0.0095	995		
Vermi compost + Poultry manure	82 (64.90)	8.23	7.66	0.0136	1303		
Coir pith	76 (60.67)	7.57	6.34	0.0104	1057		
Coir pith + Goat manure	80 (63.44)	7.41	6.53	0.0107	1115		
Coir pith + Poultry manure	82 (64.90)	8.36	7.12	0.0129	1269		
Coir pith +FYM	77 (61.35)	7.35	6.72	0.0096	1083		
Poultry manure	81 (64.16)	7.92	6.43	0.0114	1162		
Poultry manure + Goat manure	82 (64.90)	7.42	6.53	0.0102	1144		
Goat manure	72 (58.05)	7.25	6.71	0.0103	1005		
FYM	71 (57.42)	6.39	5.63	0.0094	853		
FYM+ Goat manure	76 (60.67)	6.74	6.11	0.0101	977		
FYM+ Poultry manure	79 (62.73)	6.53	5.84	0.0106	976		
Mean	78 (62.01)	7.50	6.54	0.0110	1099		
SEd	3.0214	0.315	0.289	0.008	42.346		
CD	5.0131	0.427	0.376	0.0016	98.541		

TABLE 3. Influence (	of	organic manures on	seed of	quality	y characters
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## Influence of bio fertilizers and bio protectants on seed quality characters

The highest germination percentage (95.24 %) was recorded with V+ C media enriched with Azospirillum + Phosphobacteria followed *Pseudomonas fluorescens* + Azospirillum (90.48 %) and the minimum (82.67%) was with Soil +Sand +FYM mixture. Media enriched with Pseudomonas fluorescens + Azospirillum also recorded the higher root length was followed by Azospirillum + Phospho Bacteria and the Pseudomonas fluorescens + Azospirillum and minimum was with Phospho Bacteria applied as individual addition (Table 4).

TABLE 4. Influence of bio fertilizers and bio protectends on seed quality characters

			1	2		
Treatment	Germination	Root	Shoot	Dry Matter	Vigour	
I reatment	%	length	length		index	
a 11 a 1 5711 a		(cm)	(cm)	seedling (g)		
Soil+Sand+FYM						
Pseudomonas fluorescens	79 (62.73)	7.11	5.74	0.0104	1011	
Azospirillum	81 (64.16)	7.32	5.91	0.0107	1069	
Phospho Bacteria	76 (60.67)	6.44	6.14	0.0103	950	
Pseudomonas fluorescens + Azospirillum	84 (66.42)	7.83	6.82	0.0112	1226	
Pseudomonas fluorescens + Phospho Bacteria	81 (64.16)	6.61	6.13	0.0109	1029	
Azospirillum + Phospho Bacteria	90 (71.57)	7.71	6.88	0.0114	1314	
Mean	82 (64.90)	7.15	6.25	0.0108	1100	
SEd	2.514	0.337	0.311	0.006	55.261	
CD	3.286	0.471	0.532	0.009	108.105	
Treatment	Germination	Root	Shoot	Dry Matter Production10	Vigour	
	%	(cm)	length(cm)	seedling $^{-1}$ (g)	index	
Vermicompost+ coirpith	%	(cm)	length(cm)	seedling <sup>-1</sup> (g)	index	
Vermicompost+ coirpith Pseudomonas fluorescens	% 86 (68.03)	(cm) 7.31	length(cm) 6.21	seedling $^{-1}$ (g) 0.0115	index 1153	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum	% 86 (68.03) 86 (68.03)	(cm) 7.31 7.71	6.21 6.32	0.0115 0.0114	index 1153 1203	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria	% 86 (68.03) 86 (68.03) 78 (62.01)	7.31 7.71 6.86	6.21 6.32 6.44	0.0115 0.0114 0.0109	index 1153 1203 1047	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria Pseudomonas fluorescens + Azospirillum	% 86 (68.03) 86 (68.03) 78 (62.01) 90 (71.57)	7.31 7.71 6.86 8.37	6.21 6.32 6.44 7.41	0.0115 0.0114 0.0109 0.0121	index 1153 1203 1047 1427	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria Pseudomonas fluorescens + Azospirillum Pseudomonas fluorescens + Phospho Bacteria	% 86 (68.03) 86 (68.03) 78 (62.01) 90 (71.57) 87 (68.8)	7.31 7.71 6.86 8.37 7.22	6.21 6.32 6.44 7.41 6.23	Notice form           seedling <sup>-1</sup> (g)           0.0115           0.0114           0.0109           0.0121           0.0117	index 1153 1203 1047 1427 1084	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria Pseudomonas fluorescens + Azospirillum Pseudomonas fluorescens + Phospho Bacteria Azospirillum + Phospho Bacteria	% 86 (68.03) 86 (68.03) 78 (62.01) 90 (71.57) 87 (68.8) 92 (73.57)	7.31 7.71 6.86 8.37 7.22 7.81	6.21 6.32 6.44 7.41 6.23 7.42	Notice form           seedling <sup>-1</sup> (g)           0.0115           0.0114           0.0109           0.0121           0.0117           0.0124	index 1153 1203 1047 1427 1084 1445	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria Pseudomonas fluorescens + Azospirillum Pseudomonas fluorescens + Phospho Bacteria Azospirillum + Phospho Bacteria Mean	% 86 (68.03) 86 (68.03) 78 (62.01) 90 (71.57) 87 (68.8) 92 (73.57) 87 (68.8)	7.31 7.71 6.86 8.37 7.22 7.81 7.55	6.21 6.32 6.44 7.41 6.23 7.42 6.65	1000000000000000000000000000000000000	index 1153 1203 1047 1427 1084 1445 1227	
Vermicompost+ coirpith Pseudomonas fluorescens Azospirillum Phospho Bacteria Pseudomonas fluorescens + Azospirillum Pseudomonas fluorescens + Phospho Bacteria Azospirillum + Phospho Bacteria Mean SEd	% 86 (68.03) 86 (68.03) 78 (62.01) 90 (71.57) 87 (68.8) 92 (73.57) 87 (68.8) 2.822	7.31 7.71 6.86 8.37 7.22 7.81 7.55 0.454	6.21 6.32 6.44 7.41 6.23 7.42 6.65 0.416	10duction           seedling <sup>-1</sup> (g)           0.0115           0.0114           0.0109           0.0121           0.0117           0.0124           0.0117           0.0124           0.0117	index 1153 1203 1047 1427 1084 1445 1227 57.251	

# 5. Synergistic effect of seed and nursery management techniques on emergence and seed quality characters.

The results on synergistic effect of seed and nursery management techniques revealed that seeds designed with fortification and coating treatment, revealed that seed treated with  $ZNSO_4$  1% + Carbendazim + Imidachloprid + polycoat (93%) was sown in vermicompost and coirpith media enriched with Azospirillum + *Phosphobacteria* recorded the higher emergence(98%),speed of emergence and seedling quality characters.

<b>TABLE 6.</b> Synergistic	effect of seed and nurser	v management technic	ues on emergence and	seedling quality characters
		,		

			Germ	ination (%)			
		Soil+Sand+FYM			Man	ures	
Seed Treatments	Azospirillum+	Azospirillum+	Azophos+	Azospirillum+	Azospirillı	ım+	Azophos+
	Pseudomonas	Phosphohacteria	Pseudomonas	Pseudomonas	Phosphoh	octeria	Pseudomonas
	fluorescens	Thosphobaeteria	fluorescens	fluorescens	1 nosphote	leteria	fluorescens
Control	78 (62.01)	80 (63.44)	83 (65.65)	81 (64.16)	83 (65.65)		85 (67.22)
GA <sub>3</sub>	83 (65.65)	87 (68.87)	89 (70.63)	88 (69.73)	90 (71.57)		92 (73.57)
KH <sub>2</sub> PO4	87 (68.87)	90 (71.57)	93 (74.66)	89 (70.63)	92 (73.57)		96 (78.47)
ZNSO	88 (69 73)	89 (70 63)	95 (77.08)	91 (72 55)	93 (74 66)		98 (81 25)
Mean	84 (66 42)	87 (68 87)	90 (71.57)	97 (68 87) 87 (68 87)	00 (71 57)		93 (74 66)
Wicali	04 (00.42) T	87 (00.87) M	D (71.57)	07 (00.07) M#T	50 (71.57) T <sub>2</sub> P	M <sub>v</sub> D	95 (74.00) MuTuD
OF 1	1	IVI 0.107	D 0.412	NIX I 0. 422	1 X D		
SEd	0.243	0.197	0.413	0.422	0.843	0.684	1.412
CD	0.427	0.312	0.781	0.817	1.728	1.251	N.S.
Root length (cm	)						
		Soil+Sand+FYM			Man	ures	
Treatments	Azospirillum+	Azospirillum+	Azophos+	Azospirillum+	Azospiril	lum+	Azophos+
Treatments	Pseudomonas	Phosphobacteria	Pseudomonas	Pseudomonas	Phosphol	actoria	Pseudomonas
	fluorescens	Filospilobacteria	fluorescens	fluorescens	rnosphot	Jacterra	fluorescens
Control	10.36	10.82	11.23	11.14	11.54		11.87
GA <sub>2</sub>	12.86	13.14	13.34	13.22	13.48		13.61
KH <sub>2</sub> PO <sub>4</sub>	13.62	13.85	14 11	13.72	14.03		14 21
ZNSO.	13.02	14.11	14.43	14.24	14.52		14.77
ZN304 Maan	13.93	12.08	12.29	12.09	14.52		14.77
Mean	12.09	12.90	13.20 D	15.00	15.59	MD	15.02 M.T. D
65 I	1	M	B	MXI	IXB	MXB	MXIXB
SEd	0.019	0.014	0.037	0.041	0.089	0.062	0.143
CD	0.043	0.036	0.076	0.087	0.154	0.116	N.S.
Shoot length (cn	1)						
		Soil+Sand+FYM			Man	ures	
Tractments	Azospirillum+	Azooninillum	Azophos+	Azospirillum+	A zoopinil	1	Azophos+
Treatments	Pseudomonas	Azospirinum+	Pseudomonas	Pseudomonas	Azospirii	ium+	Pseudomonas
	fluorescens	Phosphobacteria	fluorescens	fluorescens	Phosphot	bacteria	fluorescens
Control	8 71	9 41	10.05	9.91	10.22		10.48
GA	10.87	11.17	11 35	11.26	11.52		11.65
KH PO	11.44	11.17	11.55	11.20	11.02		12.06
	11.44	11.00	12.02	11.70	11.94		12.00
ZINSO <sub>4</sub>	11.02	11.75	12.02	11.07	12.21		12.40
Mean	10.66	11.00	11.32 D	11.21	11.47	14 D	11.00
	1	M	В	MXI	IXB	MXB	MXIXB
SEd	0.421	0.343	0.687	0.815	1.524	1.168	2.641
CD	0.943	0.711	1.326	1.501	2.964	2.112	N.S.
Dry matter prod	uction g per 10 seed	llings					
		Soil+Sand+FYM			Man	ures	
Tasstassanta	Azospirillum+	A	Azophos+	Azospirillum+	A = 0 0 m i mi 11.		Azophos+
Treatments	Pseudomonas	Azospirilium+	Pseudomonas	Pseudomonas	Azospirint	im+	Pseudomonas
	fluorescens	Phosphobacteria	fluorescens	fluorescens	Phosphoba	icteria	fluorescens
Control	0.0116	0.0124	0.0132	0.0121	0.0129		0.0138
GA.	0.0122	0.0129	0.0132	0.0125	0.0125		0.0147
KU DO	0.0122			11111/3	1111130		
N 1 1 - F 1 1 -	0.0126	0.0127	0.0133	0.0125	0.0136		0.0147
	0.0126	0.0137	0.0133	0.0125 0.0128 0.0137	0.0136		0.0147
ZNSO <sub>4</sub>	0.0126 0.0131 0.0124	0.0137 0.0145 0.0124	0.0133 0.0143 0.0152	0.0125 0.0128 0.0137 0.0128	0.0136 0.0147 0.0156		0.0147 0.0151 0.0169
ZNSO <sub>4</sub> Mean	0.0126 0.0131 0.0124	0.0125 0.0137 0.0145 0.0134	0.0133 0.0143 0.0152 0.0141	0.0125 0.0128 0.0137 0.0128	0.0136 0.0147 0.0156 0.0142		0.0147 0.0151 0.0169 0.0151
ZNSO <sub>4</sub> Mean	0.0126 0.0131 0.0124 T	0.0137 0.0145 0.0134 M	0.0133 0.0143 0.0152 0.0141 B	0.0125 0.0128 0.0137 0.0128 MxT	0.0136 0.0147 0.0156 0.0142 TxB	MxB	0.0151 0.0169 0.0151 MxTxB
ZNSO <sub>4</sub> Mean	0.0126 0.0131 0.0124 T 0.006	0.0137 0.0145 0.0134 M 0.003	0.0133 0.0143 0.0152 0.0141 B 0.006	0.0123 0.0128 0.0137 0.0128 MxT 0.009	0.0136 0.0147 0.0156 0.0142 TxB 0.008	MxB 0.007	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011
ZNSO <sub>4</sub> Mean SEd CD	0.0126 0.0131 0.0124 T 0.006 0.0017	0.0137 0.0145 0.0134 M 0.003 0.005	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011	MxB 0.007 0.0012	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S
ZNSO <sub>4</sub> Mean SEd CD Vigour index	0.0126 0.0131 0.0124 T 0.006 0.0017	0.0137 0.0145 0.0134 M 0.003 0.005	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011	MxB 0.007 0.0012	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S
XNSO <sub>4</sub> Mean SEd CD Vigour index	0.0126 0.0131 0.0124 T 0.006 0.0017	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu	MxB 0.007 0.0012 Ires	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S
ZNSO <sub>4</sub> Mean SEd CD Vigour index	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM	0.0133 0.0133 0.0152 0.0141 B 0.006 0.007 Azophos+	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu	MxB 0.007 0.0012	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+
ZNSO <sub>4</sub> Mean SEd CD Vigour index Treatments	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+	0.0133 0.0133 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu	MxB 0.007 0.0012 mes	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas
ZNSO <sub>4</sub> Mean SEd CD Vigour index Treatments	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria	0.0133 0.0133 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba	MxB 0.007 0.0012 mres mr+ acteria	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens
ZNSO <sub>4</sub> Mean SEd CD Vigour index Treatments	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria	0.0133 0.0133 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba	MxB 0.007 0.0012 Irres Im+ Icteria	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893
XHyi O4 ZNSO4 Mean SEd CD Vigour index Treatments Control GA2	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109	0.0133 0.0133 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245	MxB 0.007 0.0012 mres m+ acteria	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320
XHy O4 ZNSO4 Mean SEd CD Vigour index Treatments Control GA <sub>3</sub> KH,PO	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirilh Phosphoba 1799 2245 2385	MxB 0.007 0.0012 mres m+ icteria	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520
INHPLO4         ZNSO4         Mean         SEd         CD         Vigour index         Treatments         Control         GA3         KH2PO4         ZNSO	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174 2242	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292 2306	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411 2510	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264 2371	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245 2385 2482	MxB 0.007 0.0012 Irres Im+ Int+ Interia	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520 2667
XN91 O4 ZNSO4 Mean SEd CD Vigour index Treatments Control GA3 KH2PO4 ZNSO4 Mean	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174 2242 1064	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292 2296 2077	0.0133 0.0133 0.0132 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411 2510 2218	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264 2371 2120	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245 2385 2482 2328	MxB 0.007 0.0012 Irres Im+ Int+ Interia	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520 2667 2350
XN204         ZNSO4         Mean         SEd         CD         Vigour index         Treatments         Control         GA3         KH2PO4         ZNSO4         Mean	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174 2242 1964 T	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292 2296 2077	0.0133 0.0133 0.0132 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411 2510 2218	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264 2371 2120	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245 2385 2482 2228 T D	MxB 0.007 0.0012 mres im+ acteria	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520 2667 2350 M X T D
XNSO <sub>4</sub> Mean SEd CD Vigour index Treatments Control GA <sub>3</sub> KH <sub>2</sub> PO <sub>4</sub> ZNSO <sub>4</sub> Mean	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174 2242 1964 T	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292 2296 2077 M	0.0133 0.0133 0.0132 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411 2510 2218 B 0.0143 0.0152 0.0141 0.006 0.007 0.0141 0.006 0.007	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264 2371 2120 MxT 0.02	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245 2385 2482 2228 TxB	MxB 0.007 0.0012 mres m+ acteria MxB	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520 2667 2350 MxTxB
XN204         ZNSO4         Mean         SEd         CD         Vigour index         Treatments         Control         GA3         KH2PO4         ZNSO4         Mean         SEd	0.0126 0.0131 0.0124 T 0.006 0.0017 Azospirillum+ Pseudomonas fluorescens 1479 1961 2174 2242 1964 T 5.210	0.0137 0.0145 0.0134 M 0.003 0.005 Soil+Sand+FYM Azospirillum+ Phosphobacteria 1610 2109 2292 2296 2077 M 2.341	0.0133 0.0143 0.0152 0.0141 B 0.006 0.007 Azophos+ Pseudomonas fluorescens 1759 2192 2411 2510 2218 B 8.114	0.0125 0.0128 0.0137 0.0128 MxT 0.009 0.0021 Azospirillum+ Pseudomonas fluorescens 1697 2148 2264 2371 2120 MxT 9.435	0.0136 0.0147 0.0156 0.0142 TxB 0.008 0.0011 Manu Azospirillu Phosphoba 1799 2245 2385 2482 2228 TxB 17.422	MxB 0.007 0.0012 mres mm+ acteria MxB 12.426	0.0147 0.0151 0.0169 0.0151 MxTxB 0.0011 N.S Azophos+ Pseudomonas fluorescens 1893 2320 2520 2667 2350 MxTxB 31.523

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