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Influence of Seed Fortification Treatment with Inorganic Nutrients in *Jatropha Curcas* (L.)

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Abstract Studies were conducted to evaluate the influence of seed fortification treatment with growth stimulants of inorganic nutrients viz., thiourea, KNO_3, K_2SO_4, KH_2PO_4, Na_2HPO_4, $ZnSO_4$, $FeSO_4$, $MgSO_4$, $MnSO_4$ and NaCl prepared in two concentrations viz., 0.5% and 1%. The seeds were removed at 16 h soaking duration and were sown in sand media under germination room condition (25℃, 95 ± 2% RH) and raised bed nursery along with water soaked and control seeds. The results revealed that among the inorganic nutrients K_2SO_4 at 0.5% concentration had better seed invigourative effect, which recorded 44% and 55% than control in both controlled germination room and nursery bed respectively. However, shoot length, dry weight and fresh weight expressed a significant influence on seedling quality characters with the fortified seeds.

Keywords Seed invigouration; Inorganic nutrients; Nursery; Seedling production

Introduction

Researchers (Hatano and Asakawa, 1964; Khan, 1977; Nagao and Furutani, 1986; Bhattacharya, 1991 and Supari et al., 1993) with decades of their understanding emphasized the need for exogenous application of growth stimulants for improving the germination and vigour status of seeds (Kumaran et al., 1993) as the growth and development of plants are under the control of endogenous level of growth regulating substances within the seed (Pandey and Sinha, 1995). Researchers recommend various growth regulators, inorganic and organic nutrients to invigourate the seeds of agricultural, which vary with their responses, depending on species and the initial quality of the seed lot. In the present study, evaluation were made on *Jatropha curcas*, the emerging biodiesel crop of the future on standardization of a cost effective pre-sowing seed treatment for production of quality seedling at nursery.

1 Result and Discussion

Nutrients are the other alternatives to growth regulators as they are cost effective and the lethality rate will be lesser at supra optimal conditions. In addition they are also easily available than the growth regulator. The study was formulated to fortify the seeds with micro and macro nutrients in the form of different compounds in two different concentrations of 0.5% and 1% with the soaking durations of 16 h adopting the seed to solution ratio of 1:1 revealed that among the nutrients, seeds fortified with 1% K_2SO_4 enhanced the seed and seedling quality characters at controlled room condition (Table 1) and it was followed by 0.5% KH_2PO_4. The hike due to the soaking treatment with 0.5% K_2SO_4 for 16 h was observed to be 44%, 32.8%, 15.3%, 25% and 54.9% over control seeds, respectively for seedling percent, root length, shoot length, dry matter production and vigour index.

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Table 1 Influence of inorganic fortification treatment on *Jatropha curcas* seeds with different concentrations under controlled germination room condition

Nutritions (N)	Concentrations (C)					
	0.5%	1%	Mean	0.5%	1%	Mean
	Germination (%)			Shoot length (cm)		
Thiourea	38 (38.1)	40 (39.2)	39 (38.7)	28.1	27.2	27.7
KNO_3	48 (43.9)	48 (43.9)	48 (43.9)	30.1	28.0	29.1
K_2SO_4	58 (49.6)	45 (42.1)	52 (45.9)	30.8	30.5	30.7
KH_2PO_4	53 (46.7)	45 (42.1)	49 (44.4)	31.3	29.7	30.5
Na_2HPO_4	43 (41.0)	43 (41.0)	43 (41.0)	28.3	28.2	28.3
$ZnSO_4$	46 (42.7)	35 (36.2)	41 (39.5)	29.7	27.2	28.5
$FeSO_4$	48 (43.9)	48 (43.9)	48 (43.9)	30.7	30.0	30.4
$MgSO_4$	43 (41.0)	28 (31.9)	36 (36.5)	30.5	29.5	30.0
$MnSO_4$	48 (43.9)	43 (41.0)	46 (42.7)	30.1	29.9	30.0
NaCl	35 (36.2)	33 (35.0)	34 (35.7)	30.9	28.6	29.8
Water	45 (42.1)	45 (42.1)	45(42.1)	27.8	27.8	27.8
Control	*32* (34.1)	32 (34.1)	32 (34.1)	26.1	26.1	26.1
Mean	44 (42.0)	40 (39.7)		29.4	28.7	
CD (P=0.05)	N	C	N x C	N	C	N x C
	8.1	3.3	NS	2.1	NS	NS
Nutrients (N)	Root length (cm)			Fresh weight / 10 seedlings (g)		
Thiourea	5.7	5.0	5.4	32.8	36.0	34.4
KNO_3	6.0	5.3	5.7	44.1	36.5	40.3
K_2SO_4	6.4	6.1	6.3	48.6	54.0	51.3
KH_2PO_4	7.5	6.1	6.8	37.1	44.2	40.7
Na_2HPO_4	5.6	5.0	5.3	38.5	35.5	37.0
$ZnSO_4$	6.0	3.6	4.8	39.7	33.2	36.5
$FeSO_4$	6.5	5.6	6.1	45.5	49.0	47.3
$MgSO_4$	5.7	5.0	5.4	45.2	44.2	44.7
$MnSO_4$	6.1	5.6	5.9	55.4	49.4	52.4
NaCl	5.5	5.2	5.4	44.7	43.6	44.2
Water	5.0	5.0	5.0	40.2	40.2	40.2
Control	4.3	4.3	4.3	38.1	38.1	38.1
Mean	5.8	5.3		43.2	42.6	
CD (P=0.05)	N	C	N x C	N	C	N x C
	1.1	0.5	NS	6.0	NS	NS
Nutrients (N)	Dry weight / 10 seedlings (g)			Vigour index		
Thiourea	2.7	2.8	2.8	1222	1354	1288
KNO_3	3.4	2.2	2.8	1734	1593	1663
K_2SO_4	3.2	3.2	3.2	2139	1667	1903
KH_2PO_4	2.7	3.1	2.9	2053	1616	1834
Na_2HPO_4	2.8	2.5	2.6	1453	1440	1446
$ZnSO_4$	2.9	3.3	3.1	1640	1079	1360
$FeSO_4$	3.1	2.7	2.9	1749	1744	1746
$MgSO_4$	2.5	3.1	2.8	1555	965	1260
$MnSO_4$	3.4	3.0	3.2	1513	1549	1531
NaCl	3.1	2.4	2.7	1278	1100	1189
Water	2.7	2.7	2.7	1491	1458	1474
Control	2.4	2.4	2.4	964	964	964
Mean	2.9	2.8		1566	1377	
CD (P=0.05)	N	C	N x C	N	C	N x C
	NS	NS	NS	320.6	130.9	NS

Table 2 Influence of inorganic fortification treatment on *Jatropha curcas* seeds with different concentrations under nursery condition

Nutritions (N)	Concentration (C)					
	0.5%	1%	Mean	0.5%	1%	Mean
	Germination (%)			Shoot length (cm)		
Thiourea	28 (25.0)	18 (25.3)	23 (25.2)	18.8	18.4	18.6
KNO_3	47 (37.6)	33 (35.2)	40 (36.4)	21.0	20.5	20.8
K_2SO_4	49 (38.3)	33 (35.0)	41 (36.7)	21.7	21.2	21.4
KH_2PO_4	47 (37.6)	25 (30.1)	36 (33.9)	23.1	22.8	22.9
Na_2HPO_4	34 (29.5)	18 (25.2)	26 (27.4)	19.6	18.0	18.8
$ZnSO_4$	46 (42.7)	30 (38.6)	38 (40.7)	22.1	18.1	20.1
$FeSO_4$	39 (38.7)	32 (34.5)	36 (36.6)	17.3	19.1	18.2
$MgSO_4$	27 (24.4)	15 (23.1)	21 (23.8)	18.3	17.2	17.7
$MnSO_4$	29 (25.9)	26 (30.8)	28 (28.4)	19.0	16.6	17.8
NaCl	43 (35.2)	29 (32.7)	36 (34.0)	16.8	17.0	16.9
Water	34 (29.4)	34 (29.4)	29 (29.4)	17.5	17.5	20.5
Control	22 (27.7)	22 (27.7)	22 (27.7)	16.4	16.4	16.4
Mean	37 (32.7)	26 (30.6)		19.4	18.9	
CD (P=0.05)	N	C	N x C	N	C	N x C
	7.6	3.1 (0.9)	4.5 (2.9)	2.6	NS	NS
Nutrients (N)	Root length (cm)			Fresh weight / 10 seedlings (g)		
Thiourea	6.6	6.5	6.5	57.5	57.1	57.3
KNO_3	7.0	7.1	7.1	62.5	61.1	61.8
K_2SO_4	8.0	7.0	7.5	65.2	59.1	62.2
KH_2PO_4	6.5	9.0	7.8	67.2	60.6	63.9
Na_2HPO_4	5.0	6.0	5.5	54.2	55.4	54.8
$ZnSO_4$	6.5	7.5	7.0	57.6	59.6	58.6
$FeSO_4$	6.5	5.0	5.8	64.2	54.5	59.4
$MgSO_4$	4.5	5.5	5.0	43.5	54.5	49.0
$MnSO_4$	6.0	5.2	5.6	56.0	41.5	48.8
NaCl	6.0	6.0	6.0	45.5	51.6	48.6
Water	4.5	4.5	4.5	44.7	44.7	44.7
Control	4.1	4.1	4.1	43.2	43.2	43.2
Mean	6.4	5.6				
CD (P=0.05)	N	C	N x C	N	C	N x C
	0.9	0.4	NS	10.4	NS	NS
Nutrients (N)	Dry weight / 10 seedlings (g)			Vigour index		
Thiourea	5.0	5.1	5.1	707	462	584
KNO_3	5.3	5.4	5.4	1310	890	1100
K_2SO_4	5.4	5.7	5.5	1438	929	1183
KH_2PO_4	6.0	5.5	5.7	1501	735	1118
Na_2HPO_4	5.2	5.4	5.3	875	413	644
$ZnSO_4$	6.1	5.7	5.9	1178	857	1017
$FeSO_4$	6.1	5.4	5.7	919	761	840
$MgSO_4$	4.4	5.0	4.7	615	345	480
$MnSO_4$	5.1	4.1	4.6	734	569	652
NaCl	4.7	4.9	4.8	966	683	825
Water	4.4	4.4	4.4	849	849	849
Control	4.1	4.1	4.1	440	440	440
Mean	5.1	5.0		961	661	
CD (P=0.05)	N	C	N x C	N	C	N x C
	0.8	NS	NS	240.1	98.0	NS

From the Table 2, the results shows that same as in controlled condition the *Jatropha* seeds fortified with 0.5% K_2SO_4 were improved the seed and seedling quality characteristics viz., 55%, 24.4%, 48.8%, 24.1% and 69.4% over the control seeds, respectively for seedling percent, root length, shoot length, dry matter production and vigour index. Followed by KNO_3, KH_2PO_4 and $ZnSO_4$ (0.5%) enhanced the seed and seedling quality characters. Among the treatments, 1% Thiourea, $MgSO_4$ and Na_2HPO_4 was found to reduce the seed germination as 18% and 31.8% respectively than the control due to the toxic effect on physiological and biochemical processes within the cell (Swartz, 1941).

The increase in seedling per cent obtained with 0.5% K_2SO_4 for 16 h might be due to the action of potash and sulphur which, acted as invigourative agents that maintained a state of swelling on hydration, which would have congenial for the development of plasma colloids and further seedling development (Kamfer and Zehlar, 1967). Sulphur in K_2SO_4 also increased the levels of vitamins, biotins and thiamin and its coenzymes in seeds and enhanced the growth rate of seedling (Renugadevi et al. 2008).

The influence of the evaluated nutrients and two different concentrations with 16 h durations of soaking were both the positive and negative in enhancing the seedling quality characteristics of Jatropha. Among the nutrients, depending on the response with concentration, the nutrients viz., KNO_3, K_2SO_4, KH_2PO_4, $ZnSO_4$, $MnSO_4$ and $FeSO_4$ (0.5%) at 16 h soaking were better compared to control seeds which, might be due to the beneficial action of various chemicals (Rattan and Goswami, 2003) in improving the physiological function as below. However, the seed quality characters were found to be invigourative even with simple water soaking compared to the control.

Kumaran et al. (1996) in neem also suggested that soaking of seeds in 2% KH_2PO_4 for 24 h improved the germination and vigour of seeds. However, in Jatropha, Kathiravan (2004) reported that 1% $ZnSO_4$ increased the survival percent of seed at nursery by 16% and in *Bambusa* bamboo, Krishnaveni et al. (2010) found that one per cent KNO_3 increased 29% seed germination than controlled seeds at nursery condition. In the present study with *Jatropha* seeds fortified with 0.5% K_2SO_4 for sixteen hours in equal volume found to have invigorative effect on the seed that resulted in production of quality seedling and hence could be advocated as a pre-sowing nursery management technique for production of *Jatropha* seedling. Similar study has also been reported by Masilamani and Dharmalingam (1995), Singh et al. (1998), Gopikumar et al. (1991), Palani et al. (1996), Agboola (2003), Renugadevi et al. (2008) and Selvakumari et al. (2007), on *Grevillea robusta*, *Commiphora weightii*, *Cassia fistula*, *Albizzia lebbeck*, *Ceiba pentandra*, *Cyamopsis tetragonoloba* and *Callistephus chinensis* respectively.

2 Conclusion

Thus the present study on seed fortification with inorganic nutrients revealed that seed soaking with 0.5% K_2SO_4 enhanced the seed germination by 44% and 55% than control in both controlled germination room and nursery bed respectively. Hence it could be advocated as a pre-sowing nursery management technique for production of *Jatropha* seedling. However, when increasing concentration of some inorganic nutrients such as thiourea, $MgSO_4$ and Na_2HPO_4 that reduced the seed germination.

3 Materials and Method

3.1 Seed source

The bulk seeds obtained from Coimbatore district (11°1’6 N 76°58’21 E), Tamil Nadu, India. Well stored Jatropha seeds were stored in ambient condition in cloth bag in normal room temperature for six months that seeds were used for this seed enhancement study.

3.2 Experimentation and materials

Jatropha seeds were fortified with inorganic nutrients viz., Thiourea, KNO_3 (Potassium Nitrate), K_2SO_4 (Potassium Sulphate), KH_2PO_4, (Potassium dihydrogen phosphate), Na_2HPO_4 (Disodium hydrogen phosphate), $ZnSO_4$ (Zinc Sulphate), $FeSO_4$ (Ferrous Sulphate), $MgSO_4$ (Megnisium sulphate), $MnSO_4$ (Manganese sulphate), and NaCl (Sodium chloride) in two concentrations viz., 0.5% and 1%.

The seeds were removed at 16 h soaking duration in equal volume and were dried back to their original moisture content of 9% and seeds were sown in 100 seeds of 4 replicates in sand media under germination room condition (25℃, 95 ± 2% RH) as well as raised bed nursery along with water soaked and control seeds.

3.3 Observations

After one month they were evaluated for their seed quality characters viz., seedling per cent (%) i.e. number of normal /healthy seedlings produced to the total seeds sown, root length (cm), shoot length (cm) and dry matter production /10 seedlings (g). The vigour index values were computed adopting the formula of Germination (%) × Total seedling length (cm) as per Abdul-Baki and Anderson (1973) as these values could express the seed quality characters inclusive of seed germination and seedling vigour.

3.4 Statistical analysis

The data gathered were statistically scrutinized as per Panse and Sukhathme, (1985) under F test of significance for understanding the level of significance among the seed treatment and seed quality characters.

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