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Influence of Seed Treatments and Foliar Sprays on Crop Growth and Seed Yield in Maize Hybrid (*Zea mays* L.) - Hema

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Abstract

The field experiments were conducted at ZARS, V.C. Farm, Mandya, during *kharif* 2015 and 2016 to study the influence of seed treatments and foliar sprays on crop growth, seed yield in maize hybrid (*Zea mays* L.) - Hema. Results showed that treatment, $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS significantly increased plant height (158.55 cm) at harvest, cob length (16.84 cm), number of seeds per cob (502), cob weight (182.20 g), seed yield per plant (153.70 g) and seed yield (43.28 q ha^{-1}) increased over control.

Keywords: Hybrid maize, zinc sulphate, thiourea and salicylic acid

Maize (*Zea mays* L.) is one of the important staple food crop of the world and ranks next to wheat and rice. It has been an important cereal because of its great production potential and adaptability under wide range of environments and occupies an important place in Indian economy, like rice, wheat and millets. Besides being a potential source of food for human being, it is also used for feeding cattle, poultry and industries for the production of starch, syrup, alcohol, acetic acid, lactic acid etc. In India, maize is grown over an area of 9.18 m. ha with a production of 24.17 m.t and productivity is 2.63 t ha^{-1} (Anon., 2016). In Karnataka, it is cultivated in an area of 1.34 m. ha with production of 3.98 m. t accounting the productivity at 2.99 t ha^{-1} (Anon., 2016).

In Karnataka there is an linear increase in area and productivity owing to potential market and less risk involved in production. As a public institute, University of Agricultural Sciences, Bengaluru has developed maize hybrid – Hema (NAH-1137) and released for general cultivation during the year 2013.

High quality seed have better planting valve, which is particularly true in case of maize. The practice of on farm seed treatment techniques has been promoted, to small-scale farmers to improve crop establishment (Harris *et al*., 2007). Treated seeds would give faster germination and absorb water under field conditions.

Seed quality enhancement technology advances seed germination and field stand establishment would enable the parental plants to capture more soil moisture, nutrient supplements, solar radiation and help to achieve synchronization of the reproductive stages of each parent (Subedi and Ma, 2008). Seed treatment with natural and inorganic material aides in fast and uniform germination, enhanced seedling life and development under extensive variety of ecological conditions brings about better and uniform harvest of the crop.

Micronutrient defiencies are usually apparent on the leaves of maize during the development of new tissue at which nutrients are most required. For example, zinc defiencies indicates broad band of yellowing tissue on one side or both sides of the leaf midrib, symptoms may appear within the first two weeks after crop it can overcome by seed treatment with micronutrients. Zinc nutrients are widely used to enhance the yield. Foliar application of Zinc Sulphates enhances the uptake and accumulation of nitrogen and finally increases the maize grain yield and also improve starch contents of forage maize (Grzebisz *et al*., 2008). Seed priming with increased the germination and emergence of maize caryopses both under laboratory and field conditions as reported by Foti *et al*. (2008).

Salicylic acid, a naturally occurring plant hormone acting as an important signaling molecule adds to tolerance against abiotic stresses. It plays a vital role in plant growth, ion uptake and transport. Salicylic acid is also involved in endogenous signaling to trigger plant defense against pathogens. Salicylic acid can also play a significant role in plant water relations photosynthesis, growth and stomatal regulation (Arfan *et al*., 2007)

under abiotic stress conditions. Thiourea is known for its dormancy breaking and germination-stimulating effects and appears to have more diverse biological activities because of its - SH group.

The hybrid seed production potentiality of the single cross hybrid Hema (NAH-1137) is comparatively less due to poor performance of inbred lines. Senescence will occur at early stage which results in poor seed filling and quality. To overcome from these problems the present investigation entitled "Influence of seed treatments and foliar sprays on crop growth, seed yield in maize hybrid-Hema" was undertaken.

Methodology

The Field experiment was conducted during *Kharif* 2015 and 2016 at ZARS, V.C. Farm, Mandya. The net plot size was 3 x 3 = 9 m^2 with planting ratio of 3:2 (Female: male). The experiment consist of ten treatments *viz.* T_1: Control, T_2 : $ZnSo_4$ @ 2 g / kg of seed, T_3: Thiourea @ 500 ppm, T_4: Salicylic acid @ 100 ppm, T_5: $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS, T_6: Thiourea @ 1000 ppm spray at 30 and 45 DAS, T_7: Salicylic acid @ 100 ppm at 30 and 45 DAS, T_8 : $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_2+ T_5), T_9: Thiourea @ 500 ppm + Thiourea @ 1000 ppm spray at 30 and 45 DAS (T_3+ T_6), T_{10}: Salicylic acid @ 100 ppm + Salicylic acid @ 100 ppm spray at 30 and 45 DAS (T_4+ T_7) and treatments were imposed, all growth parameter and yield parameter were recorded.

Results and Discussion

The plant height was recorded at different growth intervals (30 DAS, 60 DAS and at harvest) of hybrid maize. The plant height at different growth stages were significantly higher in treatment, $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_8) (43.19 cm, 156.52 cm and 158.55 cm, respectively), which was followed by salicylic acid @ 100 ppm + salicylic acid @ 100 ppm spray at 30 and 45 DAS (T_{10}) (42.06 cm, 152.83 cm and 154.58 cm, respectively). Whereas, minimum plant height was recorded in control (T_1) (34.37 cm, 125.25 cm, and 128.70 cm, respectively) (Table I). Increase in plant height might be due to $ZnSo_4$ playing an important role in plant metabolism and growth processes. It is required for formation of auxins and chlorophyll cytochrome pigment and plays an important role in the formation of enzyme (amylase and protease) and carbohydrates regulation and appropriate root development. The increased and faster field emergence increased resistance on the resultant plant to heat and drought ultimately resulted on increased plant height at harvest. The similar findings reported by Svilen Raykov *et al.* (2011), Nazia and laxmikant, (2010), Badshah and Ayub, (2013) and EL-Badawy and Mehasen, (2011).

Days to 50 per cent tasseling and 50 per cent silking did not differ significantly due to seed treatment and foliar sprays. However, treatment $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_8) taken least number of days for 50 per cent tasseling and 50 per cent silking (51 and 58 days, respectively), which was followed by treatment, salicylic acid 100 ppm + salicylic acid 100 ppm spray @ 30 and 45 DAS (T_{10}) (51.50 and 58.67 days, respectively) as compared to control (T_1) (52.17 and 60 days, respectively) (Table II). The zinc seed treatment reduced the period of anthesis and silking by about one day each. This might be due to speed of emergence, improved field stand and vigorous growth of plant (Dadlani *et al*., 2009).

Treatment with $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_8) gave significantly the highest cob length (16.84 cm), number of seeds per cob (502) (Table III), cob weight (182.20 g), seed yield per plant (153.70 g) (Table IV) which was followed by treatment, salicylic acid @ 100 ppm + Salicylic acid @ 100 ppm spray at 30 and 45 DAS (T_{10}), while the lowest were recorded in control (T_1) (13.63 cm, 385, 160.00 g and 123.00 g, respectively). This might be due to increase in availability of Zn due to seed treatment and direct absorption of Zn by foliar spray. The proper and adequate supply of Zn increased the uptake of N during the grain formation stage and ultimately improved the yield component of maize (Siddiqui *et al*., 2009). Positive effect on the uptake of nitrogen during the milking and grain formation stage has also been found with early stage Zn application (Grzebisz *et al*., 2008). Similarly, Potarzycki and Grzebisz, (2009) also reported Zn application as a positive factor for the maximum productivity of nitrogen fertilizer.

Seed yield per ha^{-1} (Table IV) differed significantly due to seed treatments and foliar sprays.

TABLE I

Influence of seed treatments and foliar sprays on plant height at 30 DAS, 60 DAS and at harvest in maize hybrid-Hema (Kharif 2015 and 2016)

Treatments	Plant height (cm)								
	30 DAS			60 DAS			Harvest		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T1: Control	32.97	35.77	34.37	121.63	128.87	125.25	125.54	131.85	128.70
T2 : ZnSo4 @ 2 g/kg of seed	39.95	41.89	40.92	147.18	149.48	148.33	149.32	151.41	150.36
T3: Thiourea @ 500 ppm	36.23	36.73	36.48	128.32	136.74	132.53	132.54	138.45	135.50
T4: Salicylic acid @ 100 ppm	39.54	41.99	40.77	145.13	146.32	145.72	148.13	148.27	148.20
T5 : ZnSo4 @ 2 % spray at 30 and 45 DAS	38.95	40.41	39.68	151.27	152.27	151.72	152.84	154.93	153.88
T6: Thiourea @ 1000 ppm spray at 30 and 45 DAS	34.50	36.19	35.35	130.90	134.41	132.66	134.45	136.29	135.37
T7: Salicylic acid @ 100 ppm at 30 and 45 DAS	36.73	37.60	37.16	148.54	149.62	149.08	150.60	151.07	150.84
T8: ZnSo4 @ 2 g/kg of seed + ZnSo4 @ 2 % spray at 30 and 45 DAS (T2+ T5)	42.13	44.25	43.19	155.97	157.06	156.52	158.28	158.81	158.55
T9: Thiourea @ 500 ppm + Thiourea @ 1000 ppm spray at 30 and 45 DAS (T3+ T6)	35.90	36.95	36.43	130.38	132.80	131.59	132.49	136.50	134.50
T10: Salicylic acid @ 100 ppm + Salicylic acid @ 100 ppm spray at 30 and 45 DAS (T4+ T7)	40.97	43.15	42.06	150.61	155.04	152.83	152.89	156.28	154.58
S. Em+	1.86	2.07	1.94	5.96	6.55	5.82	6.01	6.27	5.93
CD (P=0.05)	5.43	6.06	5.68	17.39	19.12	16.99	17.54	18.31	17.32
CV (%)	8.50	9.12	8.72	7.29	7.89	7.07	7.21	7.46	7.08

Note: DAS-Days after sowing

TABLE II

Influence of seed treatments and foliar sprays on Days to 50 per cent tasseling and 50 per cent silking in maize hybrid-Hema (Kharif 2015 and 2016)

Treatments	Days to 50 % tasseling			Days to 50 % silking		
	2015	2016	Pooled	2015	2016	Pooled
T_1: Control	52.00	52.33	52.17	60.00	60.00	60.00
T_2 : $ZnSo_4$ @ 2 g/kg of seed	51.00	51.33	51.17	58.67	59.00	58.83
T_3: Thiourea @ 500 ppm	52.00	52.00	52.00	59.67	59.67	59.67
T_4: Salicylic acid @ 100 ppm	51.33	51.67	51.50	58.33	58.67	58.50
T_5 : $ZnSo_4$ @ 2 % spray at 30 and 45 DAS	51.00	51.00	51.00	58.67	58.67	58.67
T_6: Thiourea @ 1000 ppm spray at 30 and 45 DAS	52.00	51.33	51.67	59.00	59.00	59.00
T_7: Salicylic acid @100 ppm at 30 and 45 DAS	51.33	51.67	51.50	58.67	59.00	58.83
T_8: $ZnSo_4$ @ 2 g/kg of seed + $ZnSo_4$ @ 2 % spray at 30 and 45 DAS (T_{2+} T_5)	51.00	51.00	51.00	58.00	58.00	58.00
T_9: Thiourea @ 500 ppm + Thiourea @ 1000 ppm spray at 30 and 45 DAS (T_3+ T_6)	51.67	51.67	51.67	59.67	59.33	59.50
T_{10}: Salicylic acid @ 100 ppm + Salicylic acid @100 ppm spray at 30 and 45 DAS (T_4+ T_7)	51.33	51.67	51.50	58.67	58.67	58.67
S. Em±	0.35	0.38	0.33	0.48	0.42	0.41
CD (P=0.05)	NS	NS	NS	NS	NS	NS
CV (%)	1.19	1.28	1.11	1.42	1.23	1.20

TABLE III

Influence of seed treatments and foliar sprays on cob length (cm) and number of seeds per cob in maize hybrid-Hema (Kharif 2015 and 2016)

Treatments	Cob length (cm)			Number of seeds per cob		
	2015	2016	Pooled	2015	2016	Pooled
T1: Control	13.19	14.06	13.63	360	410	385
T2 : ZnSo4 @ 2 g/kg of seed	14.63	15.01	14.82	438	471	455
T3: Thiourea @ 500 ppm	13.73	14.62	14.18	409	426	417
T4: Salicylic acid @ 100 ppm	14.92	15.27	15.09	417	449	433
T5 : ZnSo4 @ 2 % spray at 30 and 45 DAS	15.15	14.98	15.06	452	483	467
T6: Thiourea @ 1000 ppm spray at 30 and 45 DAS	14.07	15.03	14.55	390	441	415
T7: Salicylic acid @ 100 ppm at 30 and 45 DAS	14.83	15.60	15.21	437	479	458
T8: ZnSo4 @ 2 g/ kg of seed + ZnSo4 @ 2 % spray at 30 and 45 DAS (T2+ T5)	16.56	17.13	16.84	477	527	502
T9: Thiourea @ 500 ppm + Thiourea @ 1000 ppm spray at 30 and 45 DAS (T3+ T6)	13.87	14.79	14.33	411	435	423
T10: Salicylic acid @ 100 ppm + Salicylic acid @ 100 ppm spray at 30 and 45 DAS (T4+ T7)	16.16	17.03	16.60	462	511	487
S. Em+	0.53	0.63	0.61	22.3	24.0	20.2
CD (P=0.05)	1.54	1.83	1.78	65.1	70.0	59.0
CV (%)	6.22	7.09	7.01	9.08	8.97	7.88

TABLE IV

Influence of seed treatments and foliar sprays on weight of cob (g), seed yield per plant (g) and seed yield (q ha^{-1}) in maize hybrid-Hema (Kharif 2015 and 2016)

Treatments	Weight of Cob (g)			Seed yield per plant (g)			Seed yield (q ha^{-1})		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T1: Control	32.97	35.77	34.37	121.63	128.87	125.25	125.54	131.85	128.70
T1: Control	155.52	164.47	160.00	117.52	128.47	123.00	33.05	35.69	34.37
T2 : ZnSo4 @ 2 g/kg of seed	165.02	179.24	172.13	135.02	148.24	141.63	37.99	41.77	39.88
T3: Thiourea @ 500 ppm	149.33	173.57	161.45	119.33	142.57	130.95	33.55	40.15	36.85
T4: Salicylic acid @ 100 ppm	160.95	175.60	168.27	130.95	144.60	137.77	36.83	40.70	38.76
T5 : ZnSo4 @ 2 % spray at 30 and 45 DAS	171.06	181.09	176.08	141.06	150.09	145.58	39.68	42.24	40.96
T6: Thiourea @ 1000 ppm spray at 30 and 45 DAS	154.28	169.41	161.85	124.28	138.41	131.35	35.06	38.90	36.98
T7: Salicylic acid @ 100 ppm at 30 and 45 DAS	164.85	177.12	170.98	134.85	146.12	140.48	37.95	41.14	39.54
T8: ZnSo4 @ 2 g/ kg of seed + ZnSo4 @ 2 % spray at 30 and 45 DAS (T2+ T5)	175.41	188.99	182.20	149.41	157.99	153.70	42.08	44.48	43.28
T9: Thiourea @ 500 ppm + Thiourea @ 1000 ppm spray at 30 and 45 DAS (T3+ T6)	150.46	163.08	156.77	120.46	132.08	126.27	33.91	37.23	35.57
T10: Salicylic acid @ 100 ppm + Salicylic acid @ 100 ppm spray at 30 and 45 DAS (T4+ T7)	175.32	184.00	179.66	145.32	153.00	149.16	40.90	43.05	41.97
S. Em+	5.43	5.96	5.55	5.43	5.96	5.46	1.54	1.62	1.52
CD (P=0.05)	15.86	17.39	16.20	15.86	17.39	15.93	4.50	4.71	4.44
CV (%)	5.80	5.87	5.69	7.14	7.16	6.85	7.19	6.91	6.80

Maximum seed yield per ha^{-1} (43.28 q) was obtained in treatment, $ZnSo_4$ @ 2 g / kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_8), which was followed by treatment, (41.97 q) salicylic acid @ 100 ppm + salicylic acid @ 100 ppm spray at 30 and 45 DAS (T_{10}), while the lowest seed yield per ha^{-1} (34.37 q) were recorded in control (T_1).This increment in the seed yield of maize was due to increase in cob length, cob diameter and also Zn fertilization which attributed to the enhanced synthesis of carbohydrates and their transport to the site of grain production (Pedda-Babu *et al*., 2007). These results also confirmed with Giovacchino *et al*. (2007) and Grzebisz *et al*. (2008) in maize.

The experimental result indicated that, the seed treating chemicals $ZnSo_4$ (2g / kg of seed), thiourea (500 ppm) and salicylic acid (100 ppm) used as a seed treatment and also foliar spray, Zinc sulphate (2.0 %), Thiourea (1000 ppm) and salicylic acid (100 ppm) at 30 and 45 DAS and also used in combinations. Among the treatments, $ZnSo_4$ @ 2 g /kg of seed + $ZnSo_4$ @ 2 per cent spray at 30 and 45 DAS (T_8) imparts better crop growth and seed yield of maize hybrid-Hema, This might be because of increase in availability of Zn due to seed treatment and direct absorption of Zn by foliar spray. The proper and adequate supply of Zn increased the uptake of N during the vegetative and grain formation stage, ultimately improved the growth and yield component of maize hybrid-Hema.

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