Madras Agric. J., 2019; doi:10.29321/MAJ 2019.000279

RESEARCH ARTICLE

Effect of Different Seed Treatment on Grain Yield of Maize (*Zea mays l.*) Under Drought Stress Conditions

P. Kunjammal[1]* and J.Sukumar[2]
[1]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641003.
[2]Rathanavel Subaramaniyam- Krishi Vigayan Kendra, Triunelveli (Dt) - 627852

Received : 7th May, 2019
Revised : 13th June, 2019
Accepted : 13th June, 2019

ABSTRACT

A field experiment was conducted at College of Agricultural Technology, Kullapuram - Theni during 2016-2017 on "Effect of different seed treatment on grain yield of maize under drought conditions". The experiment was laid out in a randomized block design with seven treatments and replicated thrice. The result revealed that among the seed enhancement treatments, seed treated with $ZnSO_4$ (2 %) recorded highest plant height (154.97 cm) at 90 DAS. The higher grain yield belonged to $ZnSO_4$ (2%) (2880 kg ha^{-1}) (8.5% yield increase over control). The seed quality parameters like seed germination (98.71 %), mean seedling length (34.64 cm), mean seedling dry weight (84.74 mg), SVI-I and II (3420 and 8420) were also highest, followed by seed treatment with spent wash (20%)that along with the application of recommended dose of fertilizer increased all growth and yield attributes. The study showed that zinc sulfate can reduce the negative effects of drought stress on grain yield and its components.

Keywords: *$ZnSO_4$, KH_2PO_4, Vermi wash, Spent wash, KCl.*

INTRODUCTION

Maize (*Zea mays* L.) is considered as the third most important food crop among the cereals in India and contributes to nearly 9 per cent of the national food basket. It is the most versatile crop with wider adaptability in varied-agro-ecologies and has the highest genetic yield potential among the food grain crops. As the demand for maize is growing globally due to its multiple uses for food, feed and industrial sectors, it is needed to produce more from the same or even fewer resources. With the current and projected challenges for natural resources such as water scarcity, temperature stress, *etc.*, High and rapid germination, determine good stand establishment which results in higher yields. So fast and uniform germination is as important for superior seed production. This is particularly true for crops such as maize. Treated seeds usually would exhibit rapid germination when absorbing water under field conditions (Ashraf and Foolad,2005). Seed enhancement technology that progress seed germination and stand establishment would enable the parental plants to capture more soil moisture, nutrients, solar radiation and help to attain high synchronization of the reproductive stages of each parent (Subedi and Ma, 2005). Seed treatment with organic and inorganic materials helps in rapid and uniform germination, improved seedling vigour and growth under a wide range of environment condition resulting in better and uniform crop stand. Hence, the present study was taken up with the objective of evaluating different seed treatment practices and their effect on growth and yield of maize crop under drought condition.

MATERIAL AND METHODS

A field experiment was conducted at College of Agricultural Technology, Kullapuram - Theni during 2016-2017. The experimental site is geographically located in the southern part of Tamil Nadu at 10º06' N latitude and 77º 64' E longitudes. Maize TNAU maize hybrid Co 6 with the duration of 110 days was used as the test hybrid. Experiments consisting seven treatment with different organic and inorganic nutrients viz., T_1: Hydration and dehydration, T_2: Seed treatment with Zinc sulphate (2%), T_3: Seed treatment with KH_2PO_4 (1.0%),T_4: Seed treatment with 1% KCl, T_5: Seed treatment with Spent wash (20 %),T_6: Seed treatment with Vermi wash (75 %) and T_7: No seed treatment (control). Seed treatment for maize seeds was done by soaking seeds in the different solution for overnight and dried under shade for 2 hours. Blanket recommendation of 135:62.5:50 kg NPK ha^{-1} were applied commonly to all the treatments.

The weather parameters of College of Agricultural Technology, Kullapuram – Theni, summer 2016, the total rainfall of 68.6 mm was received in 3 rainy days.

*Corresponding author's e-mail: kunjammalpandi@gmail.com

The average maximum and minimum temperature are 35.2, 23.8°C respectively for summer 2016. An average of 81.9% of relative humidity was recorded at 07:22 hours and 40.4% was recorded at 14:22 hours in summer 2016. The evaporation and bright sunshine hours day^{-1} ranged from 5.1 to 7.7 mm and 3.8 to 9.9 hours, respectively for summer 2016.

The method of Arnon (1949) was followed for estimating chlorophyll content. The method of Anonymous (2010) was followed for estimating germination percentage, mean seedling length (cm), Mean seedling dry weight (mg). The seedling vigour index (SVI) of maize was worked out as per the method proposed by Abdul Baki and Anderson (1973)using the formula as given below.

SVI-I = Germination (%) x Mean seedling length (cm)

SVI-II = Germination (%) x Mean seedling dry weight (mg)

Spikelet sterility is the ratio of unfilled grains to the total number of spikelet present in the panicle of each plant and expressed as per cent. The various biometric observations, analytical data of plant sample and the computed data were subjected to statistical scrutiny as per the procedures are given by (Gomez and Gomez, 1984). The treatment differences were worked out at five per cent probability level.

RESULTS AND DISCUSSION

Drought is one of the most detrimental abiotic stresses across the world which is seriously hampering the productivity of agricultural crops. Maize is among the leading cereal crops in the world, but it is sensitive to drought. Maize is affected by drought at different growth stages in different regions. Germination potential, seedling growth, seedling stand establishment, overall growth and development, pollen development, silk development, anthesis-silking interval, pollination, embryo development, endosperm development, and kernel development are the events in the life of maize crop which are seriously hampered by drought stress. Plants have developed numerous strategies which enabled them to cope with with drought stress(Andersen *et al*., 2002). There is a need to further improve the level of adaptability against drought stress.

Table 1. Influence of seed treatment on Plant height (cm) 90 DAS, Chlorophyll 90 DAS, Germination (%) and Seedling Vigour Index I & II

Treatments	Plant height (cm) 90 DAS	Chlorophyll 90 DAS	Germination (%)	Mean seedling length (cm)	Mean seedling dry weight (mg)	SVI-I	SVI-II
T_1 - Hydration and dehydration	149	35.20	98.00	32.20	82.27	3170	8099
T_2 - Seed treatment with Zinc sulphate (2 %)	155	37.53	98.71	34.64	85.30	3420	8420
T_3 - Seed treatment with KH_2PO_4 (1.0 %)	153	35.42	98.34	34.13	84.10	3288	8310
T_4 - Seed treatment with 1% KCl	150	35.00	98.24	31.44	80.65	3186	8079
T_5 - Seed treatments with Vermi wash (75 %)	151	35.55	98.43	32.99	83.96	3230	8246
T_6 - Seed treatments with Spent wash (20 %)	152	36.07	98.56	33.36	84.53	3268	8331
T_7 - No treatment (Control)	146	34.04	97.00	31.10	80.12	3048	7852
SEd	1.32	0.89	0.18	0.46	1.12	42.80	103.62
CD(P=0.05)	3.76	NS	NS	1.66	3.91	160	387

At Kullapuram, College of Agricultural Technology, Theni- during crop period initial rainfall is less for past three years, overcome this conditioned enhancement treatment is an effective method to get uniform, speed and highly vigorous seedling in field condition apart from genetic and physical character ofseed. A significant difference in plant height at 90 DAS was observed due to the different seed treatment (Table 1). The higher plant height was observed in seed treatment with 2% Zinc sulphate (T_2) (154.97 cm) comparable with seed treatment 1per cent KH_2PO_4(T_3). The lowest plant height was recorded in control (T_7) (145.56cm). Increase in plant height may be due to $ZnSO_4$ and Spent wash stimulate the early root development and secondary roots that more nutrients uptake is possible at an early stage. The increased and faster field emergence increased resistance on the resultant plant to heat and drought ultimately resulted in increased plant height at harvest. The findings of Svilen Raykov*et al*. (2011), Chinnuswamy *et al*. (2001) and Nazia and Laxmikant (2010) confirmed these results.

The chlorophyll content was higher in T_2 due to 2% Zinc sulphate which delayed the chlorophyll loss from the flag leaf. This delays the leaf senescence and allows more energy through higher N uptake by the crop leads to an increase in grain protein content (Alfred *et al*., 2011). Germination was non-significant due to the influence of seed enhancement treatments. However, more germination (98.71%) obtained with T_2, followed by T_3(98.34%). WhileT_7 recorded lowest the germination (97%).

With respect to seedling vigour index, seeds obtained from a seed treatment with 2 per cent Zinc sulphate (T_2) registered significantly higher vigour index II (8420) on par with seed treatment 1per cent

KH_2PO_4 (8310) as against no seed treatment (7852). Mean seedling length and mean seedling dry weight followed a similar trend. This may be due to more accumulation and translocation of metabolites to the economic part and gave the more 100 seed weight increased the availability of food material for better germination.These results are inline with the report of Sathish*et al.,* 2012.

Table 2. Influence of seed enhancement treatments on number of cobs per plant, cob length (cm) and cob weight (g) in maize

Treatments	No of cobs plant^{-1}	Length of cob (cm)	Weight of cob (g)
T_1 - Hydration and dehydration	1.03	16.46	163.38
T_2 - Seed treatment with Zinc sulphate (2 %)	1.09	17.53	184.10
T_3 - Seed treatment with KH_2PO_4 (1.0 %)	1.08	17.38	182.00
T_4 - Seed treatment with 1% KCl	1.02	16.56	166.05
T_5 - Seed treatments with Vermi wash (75 %)	1.06	16.96	170.50
T_6 - Seed treatments with Spent wash (20 %)	1.07	17.18	181.98
T_7 - No treatment (Control)	1.02	15.90	161.37
SEd	**0.03**	**0.30**	**4.82**
CD(P=0.05)	**NS**	**0.87**	**13.73**

Increase in seed yield due to seed treatment(Table 2)was mainly due to a significant increase in yield parameters of the crop. The cob length, cob diameter, cob weight, number of seeds per cob and hundred seed weight are the major yield components which determined the final seed yield and those significantly contributed to the seed yield. Synthesis, accumulation and translocation of metabolites to the economic part are often influenced by environmental conditions, thereby influencing the yield potential of the crop. The seed priming treatment is known to exert a beneficial effect on crops by improving the planting value of seeds (Harris *et al*. 2007).

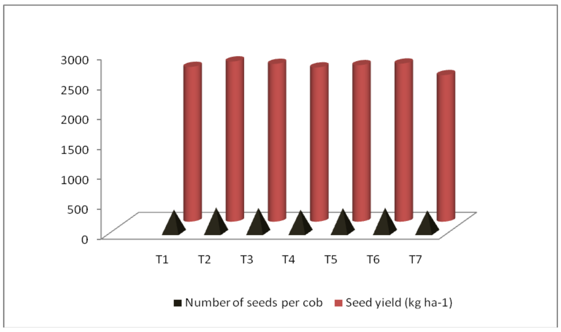


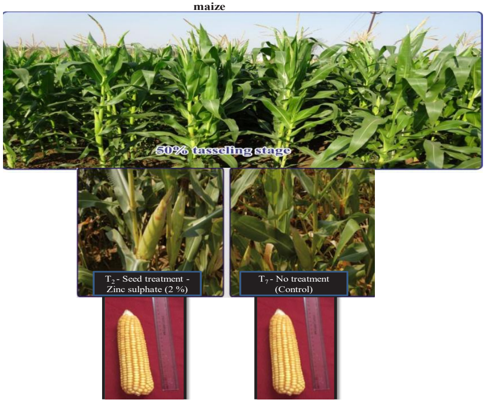
Figure 1. Effect of seed treatment on number of seeds per cob and Seed yield (kg ha^{-1}) of maize

The number of cobs per plant was not varied due to the influence of seed enhancement techniques. However, measurable number of cobs per plant (1.09) obtained with T_2, comparable withT_3 (1.07). While T_7 was recorded the lowest number of cobs per plant (1.02).It showed that the number of cobs per plant is mainly controlled by the genetic makeup of parental lines. Seed treatment with 2 per cent Zinc sulphate (T_2) gave significantly highest cob length & cob weight (17.53 cm and 184.10 respectively) on par with plots having seed treatment with 1per cent KH_2PO_4 (T_3), while the lowest values were recorded in the plots sown with seeds of no seed treatment (control). This might be due to the more sources to sink ratio there by it helped in increased seed yield.

Seed yield per hectare (Fig.1) differed significantly due to seed treatments. Highest seed yield per hectare (2680.77 kg) was obtained with seed fortification treatment of 2 per cent zinc sulphate (T_2), comparable with seed treatment with 1per cent KH_2PO_4 (T_3) (2640.00kg) while the lowest seed yield per hectare (2451.67 kg) was recorded inT_7. The increased seed yield might be due to the higher physicochemical triggering the biosynthesis of nucleic acids, proteins and the consequential enhancement of cell division besides the enhanced metabolic activity of the plants resulting on the increased uptake of nutrients by the better root system. This could have possibly accounted for improvement in crop performance and it is also due to increased final field stand, better establishment and increased growth parameters like plant height, which lead to more photosynthetic activity which in turn leads more source to sink ratio thereby it helps in increased seed yields due to seed fortification with $ZnSO_4$ (2 %) and these results also confirmed with the findings Giovacchino et al. (2001) .

All growth parameters (plant height, number of leaves, *etc.,)* were more due to seed enhancement treatments in hybrid seed production of maize, it may be due to seed enhancement treatments ensured the proper hydration, which resulted in enhanced activity of amylase that hydrolyzed the macro starch molecules into smaller and simple sugars. The availability of instant food to the germinating seeds gave a vigorous start. Due to more the amylase activity higher will be the metabolic activity in seeds, which indicated the higher vigour of the seed. The findings of these studies revealed that seed enhancement treatments enhanced the energy of emergence and vigour of seedling. A good start always effects on the final yield of crops. Shafinaziz*et al.* (2000) reported that synthesis, accumulation and

Plate 1:Effect of seed treatments on cob & cob length in maize



translocation of metabolites to the economic part are often influenced by the seed priming treatment and better root system with high population helped to get more nutrition to plant. Increase in growth and yield parameter due to seed treatment with $ZnSO_4$ and KH_2PO_4stimulate ensured the proper hydration, which resulted in enhanced activity of α-amylase that hydrolyses the macro starch molecules into smaller and simple sugars. The availability of instant food to the germinating seeds gave a vigorous start and leads to the early root development and secondary roots by that more nutrient uptake is possible at an early stage. Also, more enzyme activity is may be the reason. The increased and faster field emergence increases the resistance against biotic and abiotic stress. Among seed enhancement treatments, seed treated with 2% $ZnSO_4$ gave superior result followed by 1per cent KH_2PO_4.

CONCLUSION

Drought is one of the most detrimental abiotic stresses across the world which is seriously hampering the productivity of agricultural crops. Maize is among the leading cereal crops in the world, but it is sensitive to drought. Maize is affected by drought at different growth stages in different regions. Delaying of rainfall affect the seed germination, overcome this conditioned seed treatment is an effective method to get uniform, speed and highly vigorous seedling in field condition. In our study, seed treated with $ZnSO_4$ (2 %) superior result compare to other seed treatment method. So, Initial drought or delayaed rainfall condition seed treatment with 2 percent zinc sulphate improve seed germination and growth and development of maize.

REFERENCES

Abdul-baki, A. A. and Anderson, J. D. 1973.Vigour determination ofsoybean seeds by multiple criteria. *Crop Sci.,* **13**:630-633.

Alfred, Q. Wang, R. M.Shamsi, I. H. Jilan, G. Zang, Q.Hua, S. and Xu, H. 2011. Improving water productivity by potassiumapplication in various rice genotypes. Int. J. Agric. Biol.**13:** 9-17.

Andersen MN, Asch F, Wu Y, Jensen CR, Naested H, Mogensen VO, Koch K.E. 2002. Solubleinvertase expression is an early target of drought stress during the critical, abortion sensitivephase of young ovary development in maize. Plant Physiol **130**:591–604

Arnon, D. I. 1949.Copper enzymes in isolated chloroplast, polyphenol oxidase in *Beta vulgaris.* Plant Physiol. **24:** 1-15.

Anonymous. 2010. International rules for seed testing. *Seed Sci. and Technol.*, 24 (supplementary): 221- 228.

Ashraf, M. and Foolad M.R. 2005.Pre-sowing seed treatment-a shotgun approach to improve germination growth and crop yield under saline and none-saline conditions.Advan.Agron.,88: 223-271.

Beerappa, K.T. 2012. Influence of seed sizes, seed treatments and mother plantnutrition on seed yield and quality of sweet corn cv. Priya (*Zea mays var. rugosa.*) M.Sc.,(Agri.) thesis submitted to Uni. of Agri. Sci. Bangalore.

Chinnuswamy, C.Annadurai, K.Jayanthi, C.Veeraputhiran, R. and Karunanthi, S. 2001.Organic amendments and distillery effluent on soil fertility and productivity of rice.Proceedings of National Seminar on Use of Poor Quality Water and Sugar Industrial Effluents in Agriculture, Feb.5, TNAU, Tiruchirapalli : 84-84.

Gomez, K. A. and Gomez, A. A. 1984.Statistical procedures foragricultural research.2nd edn.John Wiley and Sons.New York.p. 680.

Giovacchino, L.D. Basti, C. Costantini, N.Ferrante, M.L. and Surrichhio, G. 2001. Effects of olive vegetable water spreading on soilcultivated with maize and grapevine. *Agric. Med.,* **131**: 33-41.

Harris, D. Rashid, A.Miraj, G., Arif, M. and Shah, H. 2007. On-farmseed priming with zinc sulphate solution - A cost effective way to increase the maize yields of resource poor farmers. Field Crops Res., **102**:119–127.

Nazia D. Khan and LaxmikantH. Kamble. 2010. Influence of spent wash application on protease and amylase activity in germinating wheat seeds. Deccan Cur. Sci., **3**(2):182-186.

Sathish, S.Sundareswaran, S.Senthil, N. and Ganesan K.N.2012.Biochemical changes due to seed priming in maize hybrid COH (M) 5,Res. J. of Seed Sci.,**5**(3):71-83.

Shafinazir, A. Jabbar.Khalid Mahmood, A. Ghaffar and Shah Nawaz. 2000. Morpho-chemical traits of wheat as influenced by presowingseed steeping in solution of different micronutrients. *Inter. J. Agri. &bio.,*60–65.

Subedi, K.D. and MA, B.L. 2005. Seed priming does not improve corn Yield in ahumid temperate environment. Agron. J.,**97**: 211-218.

Svilen Raykov, Mariela Andreeva and Milena Simeonova.2011. Influence of pre-sowing treatment of sorghum seeds Withmicroelements on the germination and growth of Plants in the initial stages oftheir development, Proceeding of the 4rd International Symposium “Newresearch in biotechnology” USAMV Bucharest, Romania.