E3 Journal of Agricultural Research and Development Vol. 3(3). pp. 035-041, May, 2013
Available online http://www.e3journals.org
ISSN: 2276-9897 © E3 Journals 2013

Full Length Research Paper

Seed Germination, Emergence and Seedling Vigor of Maize as Influenced by Pre-Sowing Fungicides Seed Treatment

Wondimeneh Taye, Fanuel Laekemariam and Gifole Gidago

Faculty of Agriculture, Department of Plant Sciences, Wolaita Sodo University, P.O box 138, Ethiopia

Accepted 6 December, 2012

Effect of pre-sowing fungicides seed treatment on seed germination, emergence and seedling vigor in maize (Zea mays L.) was evaluated at Wolaita Sodo University in 2011. The objectives of the experiment were to evaluate the effect of chemical seed treatment on germination, emergence and seedling vigor of maize under laboratory and field condition and to identify effective fungicides used for pre sowing seed treatment of maize. Four treatments (three fungicides and one untreated) ridomil, mancozeb and metalaxil at a rate of 2.5 gm/kg of seeds was used. A Completely Randomized Design was used for the laboratory experiments whereas for pot and field experiments a Randomized Complete Block Design was used. The number of replications for both experiments was four. Maize variety BH540 was used. The tested fungicides enhanced the germination of maize seeds as compare to untreated whereas, in pot trial the tested fungicides significantly affected the emergence date, fresh root and shoot weight and shoot dry weight but had no significant effect on seedling height and average leaf number. In the field experiment, the tested fungicides improved the seedling height, average leaf number, fresh and dry weight of maize seedling as compared to untreated control. In all the three experiments, metalaxil showed better effect among the tested fungicides.

Key words: Fungicides, Pre-sowing, seed treatment, ridomil, mancozeb, metalaxil

INTRODUCTION

Maize (Zea mays L.) is the third most important cereal in the world only exceeded by wheat and rice as staple food in the tropics and is a valuable source of raw material for many industrial products (Dowswell et al., 1994). It is grown from below sea level to elevations exceeding 3000 meters above sea level and at latitudes ranging from 600 North to about 400 South in the globe (Singh, 1987). It can also grow in arid regions with 250 mm of annual rainfall and in highly humid areas with a precipitation of 5000 mm (Dowswell et al., 1996). Maize has been adapted to such varied and often contrasting environments because of its enormous inherent genetic variability and its ability to yield new genotypes (Singh, 1987). In Ethiopia, maize is one of the most important cereals which can be successfully grown over a wide geographical area and variety of environments. It exceeds all other cereal crops in the country in terms of annual production and productivity (CSA, 2008). Therefore, considering its importance in terms of wide adaptation, total production and productivity, maize is one of the high priority crops to feed the ever-increasing population of the country.

The major constraints to maize production in the country include both abiotic and biotic factors, such as drought, nutrient deficiencies, weeds, diseases and insect pests (Ransom et al., 1993). The occurrence of abiotic stresses such as drought is often difficult to predict in spite of their periodic nature in some of the environments. Nutrient deficiencies are probably the most wide spread problem in Africa due to the limited use of chemical fertilizers (Ransom et al., 1993). Among the biotic stresses, diseases are one of the most important limiting factors in maize production. To date about 47 diseases have been found to affect maize and the

*Corresponding author. Email: wondimeneh2008@gmail.com

pathogens could be seed born, soil borne and air borne (Assefa and Tewabech, 1993).

Many investigations have been carried out in different parts of the world on the management of maize soil/seed borne diseases and certain chemicals have been found to be effective (Reuveni et al., 1994). Although the use of fungicides by the small-scale farmer might not be an attractive and a realistic proposition, chemicals become indispensable for quality seed production in disease pressure areas. Diseases are well known to reduce seed size, and thus adversely affect the uniformity and quality of the seed. In the study area, seedling root rot and leaf rust are the dominant diseases of maize.

Sowing seed of high quality is necessary for small scale farmer's crop production. Poor quality seeds will result in low field emergence and in seedlings that are less tolerant to abiotic stress, more sensitive to plant diseases and will reduce the quality and yield of crops produced (Ahmed and Siddiqui, 1995). Therefore, it is important to use healthy seeds. Seed treatments are commonly applied to combat seedborne diseases and diseases and pests that may be present in soil or be airborne when seedlings emerge. Specialized seed treatments such as priming, coating, pelleting are often used to improve germination or protect seeds against pathogens. In spite of the occurrence of root rot and rust on commonly grown cultivars in most parts of the study area every year, no research effort have been directed to find out the effect of chemical seed treatment on germination, emergence and seedling stand. Therefore, this research was conducted to evaluate pre-sowing fungicide seed treatment on germination, emergence and seedling stand of maize under laboratory, pot and field conditions and to enhance farmer's awareness about the importance of pre sowing fungicide seed treatment through participatory research.

MATERIALS AND METHODS

Description of the Study Area

This experiment was conducted in Wolaita Sodo University, Plant Sciences Department Laboratory and research & practical demonstration site of the Faculty. Wolaita Sodo University is located in the Southern Nation Nationalities and People regional state (SNNP), Wolaita Zone. The average annual rainfall was 1200 mm and average temperature of the area was 21- 23 0c.

Method of Seed Treatment

A 2.5 gm powder of three different fungicides, viz. Mancozeb, Metalaxil and Ridomil was added in a transparent plastic bag containing one kg of maize seed separately and thoroughly mixed by shaking plastic bag until we get uniform mixture. Little amount of water was added and thoroughly mixed in order to facilitate proper coating and the seeds were allowed to dry under shade. The dried treated seed was packed with plastic bags until use and labelled.

Laboratory Experiments

The effect of chemical seed treatment on the germination of maize seed was evaluated in department of plant sciences multipurpose laboratory, Wolaita Sodo University. Ridomil, mancozeb and metalaxil fungicides were used for the experiments.

Treatments and Experimental Design

Seeds which are treated by above mentioned fungicides once and the untreated seeds were used as control. Ten seeds in each treatment were placed in 12 cm glass petri dishes on a layer of filter paper (Whatman No 4) separately. Distil water was added as required. The experiment was conducted in CRD with four replications for both treated and normal sample.

Data Collection

Seed germination was recorded daily up to day 8, after the start of the experiment. A seed was considered germinated when radical emerged by about 2 mm in length. Then the mean germination rate was calculated according to the following equation (Ellis et al., 1981)

$$R = \sum n / \sum D.n$$

Where R is mean germination rate,
n is the number of seeds germinated on day and
D is the number of days from the start of test.

Germination percentage was also determined at the end of the test.

Pot trial: Fungicides pre sowing seed treatment effects on emergence

Treatments and Experimental Design

Seeds treated with the above three mentioned fungicides and untreated seeds were sown on two different soil (Steam sterilized soil (autoclaved) and soil from maize field) on pots at research and demonstration site of the University. Each pot was filled with equal amount of soil from each group of soil. Five seeds were sown at recommended depth and watering was done as per the requirements. The experiment was conducted on RCBD with four replicates.

Table 1: Percent germination in germination test per days as influenced by fungicide pre sowing seed treatment

Treatments/ Fungicides	Seed germination percentage per day (%)*						
	D1	D2	D3	D4	D5	D6	D7
Ridomil	0	0	17.5	47.5	67.5	90	90
Untreated	0	0	30	57.5	82.5	90	90
Mancozeb	0	0	30	75	85	97.5	100
Metalaxil	0	10	40	90	100	100	100

*It is a three consecutive germination test average data; D= day

Data Collection

With a daily observation, emergence date was recorded for each treatment (seeds recorded as emerged when the radicals appeared above the surface of substrate medium). Forty five days after seedling emergence, fresh weight of shoot and root, seedling shoot length and shoot dry weights were measured. Three seedlings from each treatment were harvested for all the above mentioned parameters.

Field Trial

The effect of pre sowing fungicides seed treatments on seedling stand of maize under field condition was evaluated as follows:

Treatments and Experimental Design

Four treatments (three fungicides types and untreated seed) were used as treatments. The experiment was laid out in randomized complete block design (RCBD) with four replications at Wolaita Sodo University research and demonstration site. Awareness creation training was given on the methods of pre sowing seed treatment for the FRG (Farmers Research Group) members in the experimental site before applying the treatments.

Prior to sowing, the experimental land was prepared. Plots were 3.6 m long and 3 m wide consisting of 4 rows with 30 cm intra-row and 75 cm inter row spacing. Each plot was spaced 1 m apart and 1.5 m spacing between blocks. Seeds were planted in rows with two seeds per hill; seedling was thinned into one plant per hill two weeks after emergence. DAP and urea were applied at the rates of 100 kg/ha and 46 kg/ha, respectively. All agronomic practices applied in the experiment were similar to the ones practiced by farmers in the area. Disease and insect prevalence was checked regularly and there was no disease and insect incidence.

Data Collection

The following vegetative growth data were collected after the FRG members evaluate the stand uniformity and giving their own ranks for the treatments (farmer seedling stand evaluation was done at the knee height of the seedling (nearly one and half a month after 50% seedling emergences). Samples were taken randomly from the central two rows. Seedling height (cm), Number of leaves /plant, Fresh weight (gm/plant) and Dry weight of shoots (gm/plant) were collected.

Data Analysis

The data analysis was performed using the General Linear Model (GLM) of Statistical Analysis System software (SAS version 9.1). Germination percentage and mean germination rate was computed by its own formula.

RESULTS AND DISCUSSION

Laboratory Experiment

The laboratory results on germination test showed variability in the first two days. Only seeds treated with metalaxil showed 10% germination at the second day and reached to 100% germination at the 5th day where as the minimum germination percentage at this time was recorded from untreated seeds (67.5%). At the end of the experiment, 90% germination was recorded from untreated seeds and seeds treated by Ridomil (Table1). Comparatively Ridomil showed lower effect on enhancing the germination capacity of the crop even the untreated seeds were in better off than Ridomil; however, there were mould development in all four replication of untreated seeds throughout the consecutive three germination tests. Almost similar results also obtained by Vimala et.al.. (1993), where they treated the eggplant seeds with three fungicides.

Similarly, the calculated mean germination rate showed variability among the treatments (Figure. 1). Seeds treated with metalaxil showed better mean germination rate than any of the treatments. Mean germination rate recorded from seeds treated with Ridomil fungicides was lower even with that of untreated seeds. The higher germination rate indicates that the fungicides in this treatment help protect the seedling against adverse conditions (Habib et al., 2007)

An increase in germination values of treated seeds compared to untreated control may be specific response

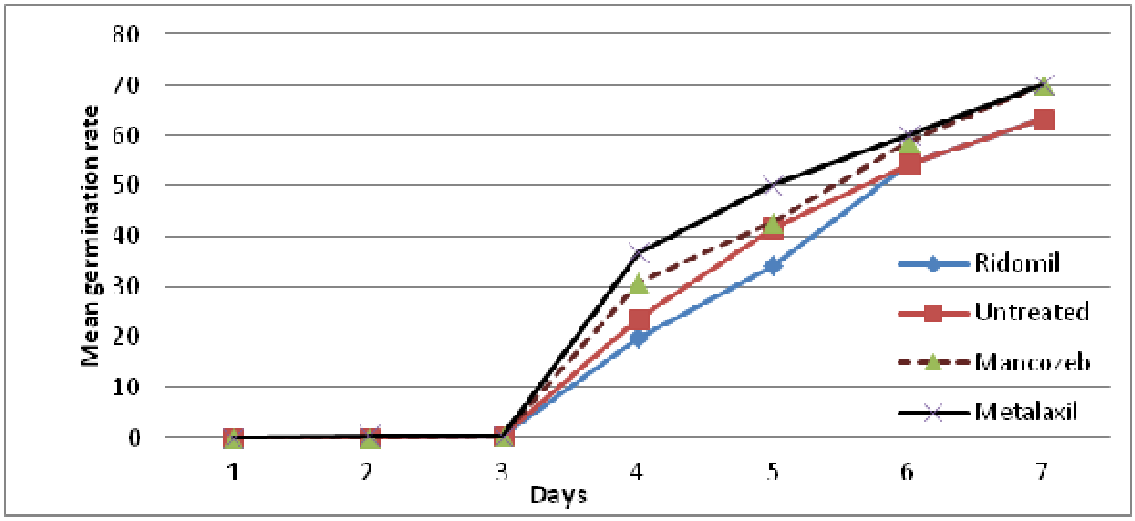

Figure1: Fungicides seed treatment effect on germination rate of maize under laboratory condition, Wolaita Sodo, 2011

Table 2: Analysis of variance of emergence date and some parameters of maize at seedling stage as affected by pre-sowing fungicides treatment on pot trial, Wolaita Sodo, 2011

		Mean Square					
Source	DF	Emerg. Date	SH (cm)	LN (no)	FRW (gm)	FSW (gm)	DW (gm)
Replication	3	0.21ns	2.18ns	0.35ns	3.17ns	4.46ns	0.04ns
Treatment	7	1.05*	4.58ns	0.34ns	7.54**	23.63*	0.73*
Error	21	0.33	4.23	0.13	0.95	4.48	0.18

* =significant @ p<0.05; ns= non-significant; DF= Degree of freedom; SH = Seedling Height, LN= leaf number; FRW= Fresh root weight, FSW= Fresh shoot weight; DW= Dry shoot weight

of Z. mays to the treatment of fungicide (Ahmed and Siddiqui, 1995). Enhancement in germination as observed in the present study has not been reported previously. The phenomenon also underscores the need for a comparative study of germination behaviour of different species in response to a particular fungicide.

Pot Experiment

Emergence Date

Pre-sowing fungicides seed treatment on maize seedling revealed significant difference (p<0.05) on 50% emergence date (Table 2). Seeds treated with metalaxil exhibited relatively fast emergence date on both soils (7.5 DAS). Whilst, the emergence date of untreated seeds delayed to any of the fungicides treated seeds. Among the fungicides, Ridomil showed least effect in enhancing the emergence date of maize seeds (Table 3).

Seedling Height

There was no significant difference (p ≥ 0.05) between fungicides treated seeds and untreated seeds on seedling height of maize seedlings on both soil (autoclaved and non-autoclaved soil) (Table 2). The maximum (14.23 cm) and minimum (11.17 cm) seedling height were recorded from seeds treated with Metalaxil and Ridomil, respectively on soils which were collected from maize farm (i.e. non-autoclaved soil). In similar fashion, Metalaxil and Ridomil exhibited maximum (12.84 cm) and minimum (11.58 cm) seedling height on autoclaved soils (Table 3).

Fresh Root Weight

Fungicide seed treatments significantly (p<0.05) affected the fresh root weight of maize seedling (Table 2) the highest fresh root weight (9.62 gm) was recorded from seeds treated with metalaxil which was sawn on autoclaved soil and also metalaxil exhibited highest root

Table 3: Effect of fungicides seed treatments on development and growth parameters of maize on pot experiment, Wolaita Sodo, 2011

Treatments (Fungicides)	DE	SH (cm)	LN (no)	FRW (gm)	FSW (gm)	DW (gm)
Unautoclaved Soil						
Untreated seed	9.25a	12.25ab	3.5c	5.64d	10.56d	1.77cd
Ridomil	8.50ab	11.17b	3.75bc	5.83cd	10.71cd	1.83cd
Mancozeb	8.25bc	13.83ab	3.92abc	6.27cd	11.29bcd	1.67d
metalaxil	7.75c	14.23a	4.33a	8.17b	13.82abc	2.34abc
Autoclaved soil						
Untreated seed	8.00bc	11.86ab	3.93abc	7.08bc	14.36ab	2.00bcd
Ridomil	8.00bc	11.58ab	4.20ab	7.88b	15.23a	2.56ab
Mancozeb	8.00bc	12.42ab	4.25ab	8.17b	16.08a	2.56ab
metalaxil	7.50c	12.84ab	4.28ab	9.62a	16.61a	2.79a
LSD $_{0.05}$	**0.84**	**3.02**	**0.53**	**1.43**	**3.11**	**0.63**
CV (%)	**16.42**	**12.6**	**8.9**	**11.3**	**15.5**	**16.9**

Means with the same letters are not significant
DF= Degree of freedom; DE= Days to emergence; SH = Seedling Height, LN= leaf number; FRW= Fresh root weight, FSW= Fresh shoot weight; DW= Dry shoot weight

Table 4: Analysis of variance for some parameters of maize at seedling stage as affected by pre-sowing fungicides treatment, Wolaita Sodo, 2011

Source	Df	Mean square			
		SH (cm)	LN (no)	FSW (gm)	DSW (gm)
Replication	3	20.65ns	0.44ns	74.19ns	3.2ns
Treatment	3	60.76*	2.54*	448.51*	19.9*
Error	9	9.09	0.12	75.85	2.99

* =significant @ p<0.05; ns= non-significant; SH = Seedling Height, LN= leaf number FSW= Fresh shoot weight; DSW= Dry shoot weight

biomass (8.17 gm) on soils of farm land. The least root biomass (5.64 gm) was recorded from untreated seeds sawn on unautocalved soil (farm land soil) (Table 3).

Fresh Shoot Weight

The analyzed data on fresh shoot weight of maize seedling showed that pre-sowing fungicides seed treatment significantly ($p<0.05$) increased the fresh shoot weight over untreated control (Table 2). The maximum (16.61 gm) was recorded from seedling raised from seeds treated with metalaxil and the least (10.56 gm) was recorded from untreated once (Table 3).

Number of Leaves

There was no significant difference ($p \geq 0.05$) between fungicides treated and untreated seeds on average number of leaves of maize seedlings on both soil (autoclaved and non-autoclaved soil) (Table 2). The maximum (4.23) average leaf numbers was recorded from maize seedling raised from seeds treated with metalaxil whereas the minimum (3.5) average leaf numbers was recorded from untreated seed. Among the tested fungicides, Ridomil showed least effects (Table 3).

Field Experiment

Seedling Height (cm)

Pre-sowing fungicides seed treatment on maize seedling revealed significant difference ($p<0.05$) on seedling height (Table 4). The highest seedling height (25.39cm) was observed from maize seeds treated by metalaxil; while the shortest seedling height (16.95cm) was recorded from seeds treated by Ridomil. The untreated seeds showed slight height difference (18.33cm) with

Table 5: Effect of fungicides seed treatment on growth of maize in field experiment, Wolaita Sodo, 2011

Treatments (Fungicides)	SH (Cm)	LN (No)	FSW (gm)	DSW (gm)
Untreated	18.33bc	5.84b	26.07b	4.86b
Ridomil	16.95c	5.91b	30.45b	6.09b
Mancozeb	22.71ab	6.38b	36.91ab	7.24b
Metalaxil	25.39a	7.56a	50.36a	10.08a
LSD $_{0.05}$	**4.81**	**0.54**	**13.93**	**2.76**
CV (%)	**14.46**	**5.33**	**14.22**	**18.47**

Means with the same letters are not significant
SH = Seedling Height, LN= leaf number; FSW= Fresh shoot weight; DSW= Dry shoot weight

seeds treated with Ridomil but not significant (Table 5).

Number of Leaves

Application of fungicides as a presowing seed treatment on maize significantly ($p \leq 0.05$) affected the number of leaves of maize seedling as evidenced in the number of leaves in treated maize seedling over untreated control (Table 3). Maize seedling raised from seeds which was treated by metalaxil showed averagely better performance (7.56) than any of the fungicides used (i.e. 6.38 and 5.91 average leaf number was observed from seedlings treated by Mancozeb and Ridomil, respectively). The average leaf numbers of untreated maize seedling was 5.84 which were relatively lower than any fungicides treated seeds (Table 4).

Fresh Shoot Weight (gm)

The tested fungicides significantly ($p<0.05$) improved the fresh shoot weight of maize seedling (Table 4). Metalaxil (50.36gm) highly improve the fresh shoot weight of maize seedling as compared to other tested fungicides and also that of the untreated control. The least fresh shoot weight (26.07gm) of maize seedling was recorded from untreated seedling (Table 5).

Dry Shoot Weight (gm)

Pre-sowing fungicides seed treatment on maize seedling revealed significant difference ($p<0.05$) on dry shoot weight of maize seedling (Table 4). Among the tested fungicides, the highest dry shoot weight (10.08 gm) was recorded from maize seeds treated with metalaxil; while the lowest dry shoot weight (6.09 gm) was recorded from seeds treated with Ridomil. The untreated seeds exhibited the lowest dry shoot weight (4.86 gm) (Table 5).

An increase in germination values of treated seeds compared to untreated control may be specific response of Z. mays to the treatment of fungicide (Ahmed and Siddiqui, 1995). Enhancement in germination as observed in the present study has not been reported previously in the study area. The phenomenon also underscores the need for a comparative study on pre sowing fungicide seed treatment of different crop varieties which are highly affected by seed or soil born pathogen in response to a particular fungicide.

In the present study, the finding revealed the significant influence of pre-sowing fungicides seed treatments on improving the germination, seedling height, average leaf number, fresh and dry shoot weight of maize seedling. Among the tested fungicides metalaxil had showed better effect throughout the experiments onto different parameters collected, then after Mancozeb and Ridomil ranks 2nd and 3rd, respectively. Resarch participant farmers also preferred Metalaxil, Mancozeb and Ridomil as 1st, 2nd and 3rd, respectively during seedling stand evaluation based on their own criteria.

Generally the experiment was showed a clear importance of pre-sowing fungicides seed treatments for small scale farmers' crop production. The treated seed results in higher field emergence and vigour seedlings as compared to untreated seeds, thus the seedling could tolerate biotic and abiotic stress thereby results better productivity. So, it is therefore, necessary to use presowing fungicides seed treatment with the objective of merely controlling or limit of the attack of pathogens and enhancing good stand establishment at the begging. Nevertheless, to drawn a sound recommendation, we, the researcher, warrant further investigation on the importance of pre-sowing seed treatments on the actual farmers' field and management conditions particularly on fungicides which showed better result. As a conclusion farmers could use metalaxil and mancozeb fungicides as a pre sowing seed treatment to enhance the germination of their maize seed and seedling vigor.

ACKNOWLEDGMENTS

The authors greatly acknowledge JICA-FRG II for funding

and the experts of the project for their unreserved communication and encouragement throughout the research time. Deepest gratitude to Dr. Yesuneh Gizaw, Vice president for academic and research, who takes the initiative to establish the partnership with JICA-FRG II and paves the way for this research to be undertaken. Harko Halala and Getachew Kefeta also highly acknowledged for their unreserved support during data collection.

REFERENCES

Ahmed S and Siddiqui ZS (1995). Effect of topsin-M (Methyl-thiophenate) fungicide on chlorophyll, protein and phenolic contents of Hibiscus esculentus and Capsicum annuum, Pak.J. Bot., 27: 175-178.

Assefa T and Tewabech T (1993). Review of maize disease research in Ethiopia, In: Benti, T. and Ransom JK (ed.) Proceedings of the First National Maize Workshop of Ethiopia, May 5-7, 1992, IAR/CIMMYT, Addis Ababa, pp. 43-51.

CSA. (2008). Agricultural sample survey reports on area and production of major crops for rural private peasant holdings, Statistical Bulletin 271: 18-19.

Dowswell, Paliwal CP and Cantrell RP (1996). Maize in the World, Boulder, Westview Press. pp. 268.

Dowswell, C.R., Paliwal, R.L and Cantrell, R.P. (1994). Maize in the Third World, West view Press, Inc. Colorado, USA.

Ellis RA and Roerts EH (1981). The quantification of ageing and survival in orthodox seeds, Seed Science and Technology. 9, p. 373-409

Habib A, Shahbaz TS, Ghazanfer MU and Safdar A (2007). Evaluation of Some Fungicides against Seed Born Mycoflora of Eggplant and Their Comparative Efficacy Regarding Seed Germination. International Journal of Agriculture and Biology, 9(3):519-520.

Ransom JK, Short K and Waddington S (1993). Improving productivity of maize under stress conditions In: Benti T and Ransom JK (ed.) Proceeding of the First National Maize Workshop of Ethiopia. Addis Ababa, May 5-7, 1992. IAR/CIMMYT, Addis Ababa, Ethiopia. pp. 30-33.

Reuveni R, Agapov V and Reuveni M (1994). Foliar spray of phosphates induces growth increase and systemic resistance to Puccinia sorghi in maize. Plant Pathology, 43: 245-250.

Singh J (1987). Field manual of maize breeding procedures. Indian Agricultural Research Institute, New Delhi, India. pp. 29.

Vimala R, K Sivaprakasam and Seethraman (1993). Effect of seed treatment fungicides and antagonistic organism on seed mycoflora and seedling vigour in brinjil. Madras Agric. J., 80: 595-7.