Journal of Applied Sciences Research, 5(12): 2234-2237, 2009

The Effect of Maize Seed Size and Depth of Planting on Seedling Emergence and Seedling Vigour

R.L Molatudi and I.K. Mariga

School of Agricultural and Environmental Sciences, University of Limpopo, P Bag X1106, Sovenga 0727. South Africa

Abstract: Smallholder (SH) farmers in Limpopo province are mostly involved in the production of maize as a staple food and thereafter sell the surplus. One of the problems experienced by the SH farmers is that of low plant stands due to their planting method of covering seeds through ploughing. The study was undertaken to determine the effect of seed size and planting depth on maize seedling emergence and growth. Treatments comprised of two seed sizes (small seed and large seed) and four planting depths (5 cm, 10 cm, 15 cm and 20 cm). Seed size was not significant but planting depth showed significant differences on emergence of seeds. Both seed size and planting depth were significant on the height of the seedlings. Seed size did not influence seedling dry weight and number of leaves. Seedling dry weight decreased with increased planting depth. Results obtained in this study show that seed size does not have an effect on emergence and seedling vigour when planted at the depth of 5 cm and 10 cm but shows an adverse effect on emergence and seedling vigour when planted at 15 cm and 20 cm depth.

Key words: Maize, smallholder farmers, seedling vigour, emergence, planting depth, seed size

INTRODUCTION

Maize (*Zea mays* L.) is the most commonly grown crop by smallholder (SH) farmers in South Africa as it is the staple food for most communities. The SH farmers usually experience problems concerning the production of this crop, one of which is that of low plant stands. Resource-poor farmers, especially those who broadcast their seeds before ploughing, mostly achieve low plant stands that lead to low grain yield. Since most SH farmers have small pieces of arable land, production of high yield is necessary. The recommended plant density for dryland maize in South Africa varies between 20 000 to 25 000 plants per hectare[1] but Lephale *et al*[2] reported maize densities between 5000 and 9000 plants ha^{-1} by 40% of SH farmers in Limpopo province where the practice of broadcasting seed ahead of a ploughing tractor is common.

Temperature and moisture affect seed emergence of maize when the seeds are planted deeply in the soil. Alessi and Power[3] found that emergence was delayed by one day for each 2.6 cm increase in depth of planting. The appropriate planting depth varies with soil and weather conditions. Barker and Swan[4] found that with an average air temperature of 10 °C, the soil temperature at the 5-cm depth was also very near 10 °C. Below 10 °C it was cooler; above 10 °C it was warmer. Shaw[5] found similar results. At shallow depths, the soil may be much warmer than air temperature during periods of intense heating, but on cloudy days, soil temperature at the planting depth closely approximates air temperature.

Maize seeds in South Africa are graded into different seed grades. The different seed sizes have different levels of germination, particularly if there is deep planting. Seed size influences seedling vigour. If farmers can plant maize shallower (at least 5 cm) their crops will be healthier, more reliable and better able to produce higher yields[6]. According to Boctes and Girardin[6], bigger seed generally translates to healthier seedlings. If seed is large the emerging seedling has a larger food source to depend on before it gets established. Seedlings from bigger seeds tend to emerge more successfully and are more vigorous both at the start of their life and throughout their whole life[6]. Hawkins and Cooper[7] reported that initial plants were larger from larger seed but the difference in plant size became smaller as the crop matured and there were no yield difference due to seed size. Vigorous seedlings are also likely to be less affected by weeds and diseases.

According to Kaufmann and Guitard[8], larger seeds produced vigorous seedlings leading to taller plants with a greater number of tillers and that took longer for wilting initiation and permanent wilting to occur

Corresponding Author: R.L Molatudi, School of Agricultural and Environmental Sciences, University of Limpopo, P Bag X1106, Sovenga 0727. South Africa
E-mail: lraisibe@gmail.com.

under increasing soil moisture stress. This emphasized the importance of having bold-seeded varieties for arid regions. The advantage of larger seeds in low yielding moisture stress conditions has also been emphasized by Gardner and Vanderlip[9]. A study was undertaken in April 2007 to determine the effect of seed size and planting depth on maize seedling emergence and growth.

MATERIALS AND METHODS

The experiment was conducted at the University of Limpopo, Mankweng, Republic of South Africa (23° 53' S, 29° 44' E) in a glass house. It consisted of two treatment factors: i) two seed sizes i.e. small seed (0.3 g) and large seed (0.6 g); and ii) four planting depths i.e. 5 cm ,10 cm , 15 cm and 20 cm . The resultant eight treatment combinations were evaluated using the same loam soil. The experiment was a 2×4 factorial arrangement in Randomized Complete Block Design (RCBD) with four replications. Blocking was done for light and for breeze from the cooling fans. Thirty two pots (30 cm in diameter) were cleaned with detergent, rinsed and dried. These were filled with autoclaved (sterilized) soil. Fifteen seeds were evenly planted in each pot (one pot per treatment per replication). The soil-filled pots were initially watered to field capacity before seed sowing and subsequently watered to 80% field capacity after every three days.

Parameters measured in the trial included: number of seedlings emerged daily from eight days after planting, seedling height at two, three, four and at five weeks after planting, seedling fresh and dry weight at five weeks after planting, and number of leaves at five weeks after planting. For number of leaves, plant height and seedling weight, five seedlings per pot were used. Data were subjected to analysis of variance using the General Linear Model of Statistical Analysis System (SAS version 14.0) and means were separated using the Least Significance Difference (LSD) method at the 5% level.

RESULTS AND DISCUSSIONS

Seed size did not significantly influence the total seedling emergence although large seed emerged more rapidly than the small seed (Table 1). Planting depth influenced both the rate of emergence and final emergence percentage (Table 1). Seedling emergence percentage and the rate of emergence decreased with increasing planting depth. At the final seedling emergence count 18 days after planting, planting depths of 5 cm and 10 cm did not differ significantly, but were significantly higher than the emergence counts for 15 cm and 20 cm depths. Seedling emergence at 5 cm depth at 18 DAP was more than double of that at 20 cm depth. There was rapid increment in seedling emergence between eight and twelve days after planting especially for the 15 cm and 20 cm depths which had lower emergence at 8 DAP compared to the shallower depths (Table 1). Emergence increments decreased considerably between 12 and 18 days after planting. The 5 cm depth had almost reached its peak emergence at 12 days after planting whereas emergence from the deeper planting depths continued increasing up to 18 days after planting (Table 1).This implies that deeper planting, apart from reducing final emergence, also exposes the germinating seeds to soil pathogens and insects thus increasing the risk of seed rots .The slow emergence exhibited by maize in this study may be due to the cooler temperatures experienced in April at Mankweng (21.3°C) maximum and (5.7 °C) minimum.

Seed size significantly influenced the seeding height. Large seed had taller seedlings as compared to small seed (Table 2). Planting depth also influenced seedling height (Table 2). Seedling height decreased with an increasing in planting depth. At five weeks after planting, seedlings from 5 cm planting depth differed significantly with those of 10 cm, 15 cm and 20 cm planting depth, respectively. Seedlings from 20 cm had significantly shorter seedlings than those of 5 cm and 10 cm depths, but were similar to those for 15 cm planting depth. Seedlings from 10 cm also had significantly shorter seedlings than those of the 5 cm planting depth.

Seed size did not influence seedling dry weight and number of leaves (Table 3). At five weeks after planting, seedlings from large seed had higher dry matter percentage (26.6 %) compared to 18.1% for seedlings from small seeds, although the difference was not statistically significant. Planting depth significantly influenced seedling dry weight and number of leaves at five weeks after planting (Table 3). Although the 5 cm depth had the biggest seedlings, their dry weight did not significantly differ with those from 10 cm and 15 cm planting depths. Seedlings from the 20 cm depth had significantly lower dry matter and number of leaves than those at 5 cm depth, but were similar to those at 10 cm and 15 cm planting depths. The higher seedling dry weight at shallower planting depths suggested these seedlings were relatively healthier and could better withstand stress. This could influence the ultimate plant stand as the crop matures.

The results of this study may partly explain the low maize stands experienced by some SH farmers in South Africa where maize seed is place deeply at planting (15-25 cm) by tractor ploughing. The farmers broadcast seed on unploughed land ahead of a ploughing tractor. Lephale *et al* [2] reported low maize

Table 1: Percentage of seeds emerged at eight, 12, 14, and at 18 days after planting as influenced by seed size and planting depth.

Seed size	8DAP	12DAP	14DAP	18DAP
Large	15.8	62.5	68.8	72.1
Small	7.5	52.5	61.3	71.7
Significance	ns	ns	ns	ns
Planting depth				
5 cm	29.2[a]	90.0[a]	95.0[a]	96.7[a]
10 cm	11.7[b]	65.0[b]	75.0[b]	81.7[a]
15 cm	3.3[b]	42.5[c]	52.5[c]	62.5[b]
20 cm	2.5[b]	32.5[c]	37.5[c]	46.7[b]
LSD (5 %)	14.89	21.02	19.48	18.88
Significance	*	**	**	**

Means followed by the same letter in a column are not significantly different at 0.05 level.
DAP= days after planting * = significant (0.05) ** = highly significant 0.01 ns= non significant

Table 2: Seedling height (cm) at two, three, four and five weeks after planting as influenced by seed size and planting depth.

Seed size	2 WAP	3 WAP	4 WAP	5 WAP
Large seed	4.1[a]	6.0[a]	6.9[a]	8.8[a]
Small seed	3.3[b]	5.3[b]	5.9[b]	7.8[b]
LSD (5%)	0.57	0.72	0.73	0.91
Significance	*	*	*	*
Planting depth				
5 cm	4.9[a]	7.2[a]	8.0[a]	10.7[a]
10 cm	3.5[b]	5.6[b]	6.2[b]	8.7[b]
15 cm	3.4[b]	5.0[b]	5.8[b]	7.5[bc]
20 cm	3.0[b]	4.8[b]	5.8[b]	6.5[c]
LSD (5 %)	0.79	1.02	1.04	1.28
Significance	**	**	**	**

Means followed by the same letter in a column are not significantly different at 0.05 level.
WAP=weeks after planting * = significant (0.05) ** = highly significant (0.01)

Table 3: Seedling dry weight and seedling dry matter percentage at five weeks after planting as influenced by seed size and planting depth.

Seed size	Seedling DW (5 plants) (g)	Number of leaves/plant
Large seed	3.44	4.2
Small seed	3.12	4.5
Significance	ns	ns
Planting depth		
5 cm	5.0[a]	4.72[a]
10 cm	3.12[ab]	4.25[ab]
15 cm	3.12[ab]	4.27[ab]
20 cm	1.87[b]	4.11[b]
LSD (5%)	2.6	0.50

Column means followed by the same letter are not significantly different at 0.05 level.
DW=dry weight ns= non significant

planting density of 5 000-19 000 plants per hectare by 40 % of SH farmers in Tzaneen district of Limpopo province as opposed to the recommended 24 000- 30 000 plants/ha. The study clearly illustrates the need for SH farmers to be sensitized on the need to plant maize at the recommended 5 cm depth and perhaps to abandon the practice of covering seed by ploughing as that is likely to place most seed too deep at the depth offset for the ploughing.

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