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Use of Purslane (*Portulaca Oleracea*) and Mulch and Their Influence on French Bean Germination Percentage and Early Seedling Growth on Saline Soil

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ABSTRACT

French bean (Phaseolus vulgaris L.) is a major vegetable export crop in Kenya and a potential income earner to small- scale farmers. The crop has been introduced to farmers in Migori county and they are eager to produce it. However, French bean poorly tolerates saline soils which occur in some areas. A study was carried out during short rain season in 2014 and long rains 2015 on saline soil in Migori county to determine the effects of purslane (Portulaca oleracea) and mulch on French bean as pertains period to emergence, germination percentage and early seedling growth. Purslane is a halophyte that can be used to desalinize soil whereas mulching is one of the conventional methods used to mitigate salinity. A 3x3 factorial experiment was planted out in a randomized complete block design, replicated three times. Treatments consisted of three French beans varieties and three methods of salinity mitigation. Data were collected on the number of days taken to emergence, germination percentage and stand count two weeks post-emergence. Data analysis was done using Genstat version 14 and the means separated by Duncan’s Multiple Range Test (DMRT). Earlier emergence and higher stand count of French beans in purslane plots indicated ameliorative effects of purslane on saline soil. Use of purslane to desalinize soil should be encouraged since the plant is also a vegetable as well as medicine. Adoption of the technology will ensure sustained mitigation method to the problem of soil salinity.

Keywords: *Portulaca oleracea*, salinity, French bean, halophyte, seedling.

INTRODUCTION

French bean is of growing importance in the socio- economic systems and livelihoods in Kenya and is one of the major vegetable export crops for East Africa, which has propelled Kenya to the pinnacle of greatness as a horticulture nation (Monda *et al.*, 2003). The crop accounts for 60% of all vegetable exports and 21% of horticultural exports (Nderitu *et al.*, 2007. The main varieties grown in Kenya for either fresh market or processing include *Paulista, Monel, Amy, Impala, Samantha, Teresa, Alexandra, Star* and *Julia* (Ndegwa *et al*., 2010).

To alleviate poverty and ensure house-holder food security in Nyatike, the study site, French bean production has just been introduced by the Government of Kenya through the Ministry of Agriculture. However, production has been hit by several challenges among them soil salinity since the crop is sensitive to salinity.

Soil salinity can be attributed to many ions present in the soil solution but adverse effects of salinity have been particularly attributed to chloride and sodium ions (Zekri, 2004). In beans, salinity stress inhibits seed germination and seedling growth, reduces nodulation, and decreases biomass accumulation and yield (Essa, 2002). These effects are induced by osmotically mediated interference with water and nutrient uptake (Brady & Weill, 2002).

The aim of this study was to investigate the effects of purslane (*Portulaca oleracea)* and mulch on French bean germination percentage and early seedling growth on saline soil.

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MATERIALS & METHODS

Site Description

The experiment was conducted in Nyatike, Migori county which lies at an altitude of 1135- 1350 m above sea level. Temperatures range between 19.3 – 30^{0}C. Rainfall is erratic but can be categorized into short and long rain seasons at a range of 600-1200 mm p.a. Soils are mostly clay but saline soils also occur (MOA, 2008).

Test crop

The test crop was French bean of which 3 varieties, (*Samantha, Monel and Star)*, were grown. The varieties were chosen for their availability in the market, farmer acceptability and marketability of the pods. The seeds were sourced from Hygrotech seed company.

Treatments

Salinity Mitigation Methods

In this study, two salinity mitigation methods together with a control were used in three replicates.

Varieties

Three French bean varieties which are the main ones grown by farmers were planted.

Seasons

The experiment was carried out in two seasons: short rain season of 2014 and long rain season of 2015.

Experimental Design and Field Layout

The experiment was a 3x3 factorial arrangement in Randomized complete block design (RCBD) with 3 varieties (V1, V2 and V3), 3 salinity mitigation methods (S1, S2 and S3) in three replicates. The design gives a total of 27 plots per season. Each plot size was 1.5 m x1 m.

The French beans were grown as recommended by Ministry of Agriculture.

DATA COLLECTION & PARAMETERS MEASURED

The parameters on which data were collected include:

- Number of days to 50% emergence

This was obtained by subtracting the date of planting from the date on which at least 50% of the seedlings had emerged to show whether the seeds emerged in time or not.

- Emergence percentage

The total emerged seedlings nine days after planting divided by the total number of seeds planted multiplied by 100 gave the germination percentage.

$$\text{Emergence percentage} = \frac{\text{Number of seedling emerged}}{\text{Total number of seeds planted}} \times 100$$

- Stand count at two weeks.

This was the total number of plants per experimental unit after two weeks of emergence. The number represents the total number of seedlings that emerged. It was obtained by counting and recording the total number of French bean seedlings two weeks post-emergence.

Statistical Analysis

The data obtained were subjected to analysis of variance (ANOVA). The mean differences were separated by Duncan's Multiple Range Test (DMRT) at 0.05 level of significance.

RESULTS

Effects of Salinity Mitigation Method and Variety on Days to 50% Emergence

Salinity mitigation method influenced the number of days taken to seedling emergence in season 2 where the control significantly differed from mulching and purslane treatments as shown in Table 1 below. Variety did not have any significant effect in either season. On average, seedlings emerged earlier in season 2 than in season 1.

Effects of Salinity Mitigation Method and Variety on Germination Percentage

Salinity mitigation methods had a significant influence on germination percentage in season 2 as shown in Table 1. Variety had a significant influence in season 1.

Effects of Salinity Mitigation Method and Variety on Stand count at 2 Weeks

There was significant difference in salinity mitigation methods used on stand count of French beans at 2 weeks post-emergence only in season 2 (Table 1). Variety had a significant effect on the stand count of French beans in season 1.

Table1. *Effects of Treatment and Varieties on Different Parameters*

Parameter	Treatment	SEASON 1				SEASON 2			
		V1	V2	V3	Mean	V1	V2	V3	Mean
Days to 50% emergence	Control	8.33	7.33	7.33	7.67**a**	8.33	7.67	8.33	8.11**a**
	Mulching	8.33	8.33	8.00	8.22**a**	7.33	7.67	8.00	7.67**ab**
	Purslane	8.00	7.67	7.67	7.78**a**	7.00	7.00	7.33	7.11**b**
	$DMRT_{0.05}$				0.86				0.60
	Mean	8.22**a**	7.78**a**	7.67**a**		7.56**a**	7.44**a**	7.89**a**	
	$DMRT_{0.05}$			1.49				1.04	
	CV (%)				10.88				7.67
Germination percentage	Control	31.90	59.00	48.60	46.51**b**	53.30	58.10	60.00	57.10**c**
	Mulching	40.90	75.20	46.70	54.28**a**	63.80	71.40	61.90	65.70**b**
	Purslane	39.00	63.80	43.80	48.88**ab**	75.20	78.10	75.20	76.20**a**
	$DMRT_{0.05}$				6.46				5.23
	Mean	37.30**c**	66.03**a**	46.34**b**		64.10**a**	69.20**a**	65.70**a**	
	$DMRT_{0.05}$			11.18					9.07
	CV (%)				13.00				7.90
Stand count at 2 weeks (seedlings/ m^2)	Control	9.00	14.00	11.00	12.00**a**	12.00	14.00	12.00	13.00**c**
	Mulching	10.00	15.00	11.00	12.00**a**	15.00	17.00	14.00	15.00**b**
	Purslane	8.00	15.00	11.00	11.44**a**	17.00	18.00	18.00	18.00**a**
	$DMRT_{0.05}$				1.17				1.70
	Mean	9.11**b**	15.00**a**	10.89**b**		15.00**a**	16.00**a**	15.00**a**	
	$DMRT_{0.05}$			2.02				2.12	
	CV (%)				10.00				8.00

Key: Means within a row or column with different letters are significantly different ($p \leq 0.05$).

V1= Monel V2= Samantha V3= Star

DISCUSSION

Effects of Salinity Mitigation Method and Variety on Days to 50% Emergence

The study showed that in season 1, none of the treatments had any significant difference from the others as per the number of days to emergence. This is because of the fact that the treatments applied had not had enough time to exert their effects (Table 1). Season 2 seedlings emerged earlier than season 1 since salinity level was lower in season 2 having been mitigated earlier in season 1. Inhibition of seedling emergence is attributed to a decrease in osmotic potential of the root zone under the effect of excessive salts which reduce the ability of the seed to absorb moisture for the expansion of the embryo (Al – Niemi *et al.*, (1992). Control had the highest mean number of days to emergence and could be attributed to the high salt concentration which retarded the growth of the radical so seedlings failed to emerge properly and in time (Qu *et al.*, 2008).

Effects of Salinity Mitigation Method and Variety on Germination Percentage

The study showed that in season 1, there was no significant difference in salinity mitigation methods as far as germination percentage is concerned (Table 1). Control had the lowest germination percentage and this is in agreement with Jeannette et al., (2002), who found out that at high salinity levels, germination percentage decreased significantly.

Shahid et al., (2011) attributed low germination percentage under salinity stress to excessive deposition of Na+ and Cl- ions in seed tissues that compromise germination metabolism by affecting mobilization of mineral and organic reserves.

Effects of Salinity Mitigation Method and Variety on Stand Count at 2 Weeks

From the experiment, there were no significant differences among salinity mitigation methods used in season 1 (Table 1). At this time, Na+ and Cl- ions had not accumulated enough in the crops to levels that they could affect stand count. In season 2 however, there was a significant difference in the salinity mitigation measures put in place. Use of purslane resulted into the highest stand count. This was due to the fact that in season 2, salinity levels on purslane plots were lower than the rest.

Use of mulching resulted in the highest stand count in season 1 and an intermediate stand count in season 2 since mulching exerts its effects immediately by controlling evapotranspiration from the soil. It was evident that salt problems were more severe under hot, dry conditions than under cool, humid conditions provided by mulch. As a consequence of reduced evaporation, soil mulching benefits the conservation of water, particularly in the topsoil, decreases the evapo-concentration of the salts present in the irrigation water and the soil solution and minimizes soil salinization and sodication (Rahman *et al*., 2006).

The least stand count was in the control which had bare soil exposing the soil to drying due to evaporation. According to Jeannette et al., (2002), as soil dries, salts become concentrated in the soil solution, increasing salt stress which results into poor germination. In his experiments on rice, Anbumalarmathi et al.,(2013) concluded that salinity results in poor crop stand due to decreased seed germination.

CONCLUSION

From the study it was found out that high soil salinity affects French bean germination and early seedling growth. Use of purslane as an intercrop mitigates the effects of salinity by lowering salinity levels.

RECOMMENDATIONS

Use of purslane is an emerging technique that can be used to cope with salinity problems.

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