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Onion (*Allium cepa* L.) Seedling Quality Parameters as Affected by Soil and Seed Treatment at Adami Tulu, Mid Rift Valley of Ethiopia

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Abstract: The integrated effects of soil and seed treatment on onion (*Allium cepa* L.) were investigated at Adami Tulu mid rift valley of Ethiopia during hot warm season (March, April and May) 2015. Leaf number, seedlings length, weed abundance, percentage of strong and weak seedling were tested for their response. Accordingly interaction effect of seed and soil treatment affected percentage of strong and weak seedling significantly at ($P < 0.01$). The main effect of seed treatment was found non-significantly affected all seedling quality parameters except seedling length whereas the main effect of soil treatment affected seedling length, and leaf number at ($P < 0.05$) weed abundance, percentage of strong and weak seedling at ($P < 0.01$). The maximum percentage of strong seedling was attained while solarization combined with treated seed (seed treated with apron star) (85%) followed by treated seed with burning (77.4%) and untreated seed with solarization (77.4%). The interaction of burning and untreated seed (4) was found to maximize leaf number followed by combined effect of burning and treated seed (4). Mean weed abundance reduced from 65.9% and 41.7% when soil is treated with solarization and burning as compared to control plot, respectively. In general increased quality of onion seedling was achieved due to combined application of soil solarization and seed treated with apron star. Therefore, combined treatment of soil solarization and seed treatment with apron star is recommended for onion nursery establishment at Adami Tulu mid rift valley of Ethiopia.

Keywords: Onion, Apron Star, Burning, Solarization, Quality Seedling

1. Introduction

Onion is considered as one of the most important vegetable crops produced on large scale in Ethiopia. It also occupies an economically important place among vegetables in the country. The area under onion is increasing from time to time mainly due to its high profitability per unit area and ease of production, and the increases in small scale irrigation areas [1]. It is widely produced in the Rift Valley area is also expanding in different production belts for its diverse economic benefits [2]. The total area under onion production in Ethiopia is estimated at 22771.88ha with a total production of 230745.2t with an average productivity of 10.04t [3].

The average productivity of onion is low and, at present, the national average yield is as low as 10.04 t ha^{-1} [3] as compared to the world average yield of 17.30 t ha^{-1} [4]. The low productivity of onion in the region mainly attributed from poor seed quality [1], and poor soil management practices [5]. The quality of seed supplied by the informal sector in most cases is not good enough with regards to purity and freeness from seed borne diseases. Most of the times there have been problems related to weak, diseased and long etiolated onion seedling. Owing to these, farmers are using 12-16kgha^{-1} of seeds as opposed to the recommended rates of 3.5-4kgh^{-1} in order to guarantee percentage of good seedling [1]. This incurs more cost to farmers besides the ever increasing price of onion seed on the local markets. All these are hampering the advancement of onion production in the rift valley of Ethiopia.

Therefore, it becomes necessary to study seedling management techniques that can improve seedling quality of onion. Hence, the seedling should be strong and vigorous in order to easily establish fields and gain better economic benefits. Therefore, this research was initiated with the

objective of identification of appropriate soil and seed treatment options for the best quality of onion seedling production in mid rift valley of Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

Adami Tulu Agricultural Research Center is located in the mid rift valley (MRV), 167km south of Addis Ababa on Awassa road. It lies at a latitude of 7° 9' N and 38° 7' E longitude. Its altitude is about 1650m.a.s.l. It has unevenly distributed average annual rainfall of 760mm. It has a bimodal rain fall extends from February to September with a dry period in May to June, which separates the preceding ''short'' rains from the following ``long'' rains. The soil is loam with sandy silt and clay in proportion of 44%, 34% and 22% respectively and pH of 7.88 [6].

2.2. Experimental Methodology

Two level of seed treatment (seed treated with apron star and untreated seed) and three levels of soil treatments (solarization, burning and control) were tested using randomized complete block design (RCBD) in factorial arrangement. The experiment was conducted during dry and warmest season (March, April and May) 2015. Recommended seed rate of 60 gram of onion seed per standard bed size (1m width and 5m length) were used. Weighted seed were treated with apron star at 10gm apron star to 4 kg of onion seed for treated seed experimental unit. Plot size of 1m width and 5m length seed bed were well prepared. The application of farm yard manure and fertilizer was $20tha^{-1}$ and $200kgha^{-1}$ (DAP) respectively were done before solarization and burning treatments applied. Covering the soil with polyethylene sheet was done after the soil was moderately irrigated to facilitate solar heat movement in the soil. UV transparent plastic sheet left in place for 5 weeks during the hottest part of the season (March to May). Weeds, livestock feed leftover and other plant materials were used to burn on well prepared seed bed for burning experimental units (plots). All plots were mulched using weed free grasses.

2.3. Statistical Analysis

The collected data were subjected to analysis of variance (ANOVA) and mean separation accomplished by least significant difference LSD at $P = 0.05$. SAS computer program (version 9.0) was used to compute the aforementioned procedures using general liner model [7].

3. Results and Discussion

3.1. Leaf Number

The interaction effect of seed and soil treatment, and main effect seed treatment was non-significantly affected mean leaf number of onion seedling at ($P < 0.05$) while the main effect of seed treatment was found significantly affected number of leaf of onion seedling at ($P < 0.05$) (Table 1). Significant mean leaf number increase was recorded from burning treatment (3.65) as compared to both solarization (3.21) and control treatments (3.18) (Table 2). The highest significant mean leaf number was recorded may be due to application of additional nutrient added through burning of crop residue.

Table 1. *Mean square error of onion seedling quality parameters at Adami Tulu, Mid Rift Valley of Ethiopia.*

Source of variation	Leaf Number	Seedling length (cm)	PWS (%)	PVS (%)	WA (m^{-2})
Replication	0.27NS	4.81*	2.34*	2.34*	3345.49NS
Seed treatment	0.57NS	5.35*	0.84NS	0.84NS	301.04NS
Soil treatment	0.56*	6.35*	13.51***	13.51***	13216.67**
SeT* SoT	0.13NS	2.47NS	4.91**	4.91***	3654.17NS
CV (%)	10.98	7.34	24.96	10.8	33.13

NB ns, * and ** non (significant, significant and highly significant respectively), CV (coefficient of variation); PVS = Percentage of vigor seedling; PWS = Percentage of week seedling; WA = Weed abundance; SeT = Seed treatment; SoT = Soil Treatment

3.2. Seedling Length

Both main effect of soil and seed treatment was found significantly affected seedling length at $P < 0.05$ while their interaction was non-significant ($P < 0.05$) (Table 1). Mean seedling length of treated seed with apron star (13.9cm) was significantly different with untreated seed (13.0cm). The present study was argued with [8] seedling of cucumber and bitter gourd achieved maximum seedling length while seed were treated with fungicide. However, the main effect of soil treatment found that no significant difference detected among solarization (13.61) and control (14.22) but significant mean seedling length was observed from burning (12.48cm) treatment as compared to other soil treatment options.

Table 2. *Main effect of seed and soil treatment on seedling quality parameters of onion.*

Seed Treatment	Leaf Number	Seedling length (cm)	PWS (%)	PSS (%)	Weed abundance (m^{-2})
TS	3.19	13.9a	3.21	7.17	115a
UnTS	3.5	13.0b	2.83	6.79	122a
LSD (0.05)	0.32	0.86	0.66	0.66	34.18
Soil Treatment					
Control	3.21b	14.22a	4.50a	5.50b	154a
Solarization	3.18b	13.61a	2.50b	7.94a	74b

Seed Treatment	Leaf Number	Seedling length (cm)	PWS (%)	PSS (%)	Weed abundance (m^{-2})
Burning	3.65a	12.48b	2.06b	7.50a	127a
LSD (0.05)	0.39	1.05	0.8	0.8	42
CV (%)	10.98	7.34	25	10.81	33.14

Means followed by the same letter is non significantly different at ($P < 0.05$); TS = Treated seed; UnTS = Untreated seed; PWS = percentage of week seedlings; PSS = Percentage of strong seedlings; LSD = Least significant difference; CV = Coefficient of Variation

3.3. Weed Abundance

The interaction effect of soil and seed treatment and main effect of seed treatment was found no significant affected weed abundance at ($P < 0.05$) while the main effect of soil treatment was found significantly affected ($P < 0.01$) (Table 1). Due to solarization weed abundance was found significantly reduced by 52% over control and 42% over burning treatment (Table 2). This could have been caused by direct thermal killing of weed seeds either before germination or soon after it had been induced by moisture in the solarized plots. The result agreed with [11] who reported similar result on chickpea and pigeon pea. The same study also confirmed solarization is a better control option for weed than burning residue on the field. On the other study [12] found solarization was found effective method in reducing orobanche shoot in tomato field in the central rift valley of Ethiopia.

3.4. Percentage of Week and Strong Seedling

Significant interaction effect of seed and soil treatment were detected for both percentage of week and strong seedling at *($P < 0.01$)* and *($P < 0.001$)*, respectively (Table 1). The highest mean percentage of strong seedling was recorded from the combined application solarization and seed treatment with apron star (85%) while the lowest recorded from the combined application of untreated soil and treated seed with apron star (45%) (Table 3). This shows that solarization are more responsible than seed treatment for the seedling quality of onion. This is may be due to increased nutrient concentration in the soil layer and reduced pathogen causing diseases. The same findings has been reported by [9] which found that concentrations of dissolved organic matter in saturated paste soil extract increased more than 100% in solarized soil. In addition to this increases in soluble mineral nutrients including NH_4^+-N, NO_3^--N, Phosphorus, K^+, Ca^{+2}, Mg^{+2}, Mn^{+2}, Fe^{+3}, Cl^- and Cu^{+2} Phosphorus, K have been detected in solarized soils [10]. On the contrary, the highest percentage of week seedlings was recorded from the combined application of untreated soil (control) and treated seed with apron star (55%) (Table 3).

Table 3. *Interaction effect of soil and seed treatment on percentage of week and strong seedlings.*

Soil Treatment	Seed treatment	PWS (%)	PSS (%)
Solarization	Apron star	15cd	85a
Solarization	Control	26bc	77a
Burning	Apron star	26bc	77a
Burning	Control	22cd	76ab
Control	Apron star	55a	45c
Control	Control	35b	65b
LSD (.05)		11	11
CV (%)		25	11

NB: Means followed by the same letter in the column are non-significantly different. PWS = percentage of week seedling; PSS = percentage of strong seedling

4. Conclusion

Onion seedling quality is becoming the major challenge for the farmers in the rift valley of Ethiopia. As a result farmers use high seed rate to compensate for the higher percentage of week seedlings which failed to establish on the main field. The present experiment suggested that soil and seed treatment is efficient in significantly increase in percentage of strong seedlings and significant reduction of weak seedling. Combined with suitability of the rift valley region for solarization and low cost technique application seed treatment with apron star at the rate of 10 per 4kg seed and soil solarization is recommended.

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