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Growth and Fruit Weight of Chilli Pepper (*Capsicum frutescens*) as Affected by Soil Sterilisation and Pricking out

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ABSTRACT

Pricking out and sterilization are regarded as very important nursery practices in certain crops but chilli farmers in northern Ghana do not practice them. Information is needed on their effects on the growth and yield of chilli pepper so as to promote these practices in northern Ghana. A field experiment was conducted at the experimental farm of the University for Development Studies, Nyankpala campus, Ghana to verify the contributions of some simple nursery soil sterilisation types, seedling pricking and their interactions to the growth and fruit weight of chilli pepper. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The treatment combinations were straw burning (to sterilize the nursery bed) with pricking out, straw burning without pricking out, solarisation (to sterilize the soil by trapping solar energy) with pricking out, solarisation with no pricking out, no solarisation with pricking out and a control which did not receive any of the treatment. The parameters studied were plant height, number of leaves, number of branches, canopy spread, number of fruits, fresh and dry fruit weight. The results revealed that, pricking out or sterilization affected most of the parameters studied independently. Pricked out plants were taller, produced more branches, produced about twice the number and weight of fruits compared to non-pricked out ones. Soil sterilization especially straw burning enhanced the production of more leaves and higher fresh fruit weight per fruit. It is concluded that plants that were nursed on sterilised soils and later pricked out were better in vegetative growth and fruit weight than those that were not. Ongoing research is quantifying the reduction in soil pathogen and weed seeds as a result of the nursery bed sterilization types under consideration.

Key words: Soil sterilisation, solarisation, pricking out, competition for growth factors

INTRODUCTION

Hot pepper is a major vegetable crop and an important constituent of local dishes in West Africa (Norman, 1992). Pepper is grown as perennial fruit vegetable crop in the tropics, but it is also grown as an annual in the sub-tropics (Swiader *et al*., 1992). The optimum growth and yield of pepper depends on good quality seeds and seedlings. According to Norman (1992) no agronomic practices can compensate for poor quality seedlings in the nursery. Seedling quality depends on its ability to quickly produce new roots, increase the speed of anchorage of roots and a balanced shoot to root ratio (Jaenicke, 1999). To survive the harsh environmental conditions in the field, good looking seedlings must develop very healthy and strong root system. It is only strong and healthy root system that can withstand some of the adverse arid conditions such as moisture stress, flooding,

salinity and nutrient deficiency (Jaenicke, 1999). High seedlings losses could occur in the nursery as a result of weed seeds and soil-borne pathogens. Application of soil amendments especially sewage sludge that is associated with urban production systems has been shown to increase the diversity of harmful soil pathogens (Amin, 2011). Pathogenic fungi have been noted to cause damping off and wilting of seedlings (Sahu and Sindhu, 2011). Doolan *et al.* (2001) reported that the quality of field grown seedlings can be improved by some simple techniques such soil sterilisation. However, only about 13% of commercial nurseries in Ghana sterilise their soils before nursing seedlings (Norman and Monney, 2002).

High seedlings losses could also occur when there is over crowding of seedlings in the nursery. Pricking out is a simple and good nursery practice that is aimed at spacing seedlings when they are about 2 weeks old or when they formed the first true leaves. Overcrowding of seedlings, weed seeds and soil borne pathogens are serious problems in small holder pepper nurseries in Ghana, especially northern Ghana where high temperatures and humid conditions persist in the rainy season (Nyarko *et al.*, 2010). Sterilisation and pricking-out could enhance rapid seedling establishment as well as increase seedlings resistant to pest and diseases and ultimately increase crop yield. There are several chemical methods of soil sterilisation including chloroform fumigation and fumigation with methyl bromide (Handiseni *et al.*, 2010; Sinegani and Hosseinpur, 2010; Darbar and Lakzian, 2007; Ikie *et al.*, 2006; Jaenicke, 1999). These chemicals are not only costly, but also pose serious health risk to humans, animals and the environment (Osman *et al.*, 2011). Kelaniyangoda *et al.* (2011) have shown the effectiveness of steam sterilisation of soil in controlling soil pathogens and improving plant growth. Soil sterilisation and pricking out are important cultural practices that could enhance seedling establishment and ultimately influence fruit weight of chilli pepper. Effect of interaction between beneficial and harmful soil microbes require good understanding and application of biologically safer soil sterilisation methods (Lartey, 2006; Heydari and Pessarakli, 2010). The effects of cultural practices on the fruit quality of vegetables were clearly demonstrated by many researchers (Aghofack-Nguemezi and Tatchago, 2010; Hwang *et al.*, 2006). Much work has been done on chemicals, steam and hot water method of sterilisation but little work has been done on burning of straw and trapping solar energy with the aid of polythene sheet (solarisation) as means of sterilisation in northern Ghana. The objective of the study was to verify the contributions of nursery soil sterilisation and seedling pricking out to the growth and fruit weight of chilli pepper.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of the University for Development studies, Nyankpala, in the Tolon-Kumbungu district of Ghana during raining season (April-November 2009) as a preliminary study. The geo-climatic condition and soil characteristics are as described by Nyarko *et al.* (2011).

Experimental designs: The design of experiment was 2×3 factorial in Randomized Complete Block Design (RCBD), with three replications. The factors and their levels are summarised in Table 1.

The treatment combinations were:

- Pricked-out seedlings which were raised on beds after straw burning
- Non-pricked out seedlings raised on beds with straw burning

Table 1: Experimental factors and factor levels used in the design

Factors	Levels
Pricking out	Pricked out seedlings
	Non pricked out seedling
Sterilisation	Seed beds with straw burning
	Seed beds sterilised by covering with polythene sheet (solarisation)
	Non sterilised seed beds

- Pricked out seedlings raised on soils with solarisation
- Non pricked out seedlings raised on soils with solarisation
- Pricked out seedlings raised on beds without straw burning or solarisation
- Non-pricked out seedlings which were raised on soils with neither straw burning nor solarisation

Experimental procedure: Six nursery beds of size 1.5×2 m were made. All beds were watered and two of the beds in each block were covered with a black polythene sheets and was left for one week under the tropical sun (solarisation). This was to allow a built up of heat on the beds to kill weed seeds and pathogens. Two of the beds in each block were also covered with rice straw (of 10 cm thickness) which was subsequently burnt after one week to kill weed seeds and pathogens and the rest of the beds were left without any sterilization to serve as control.

Chilli pepper ('Adope' variety) seeds were nursed on both sterilised and non sterilised nursery beds. Two weeks after germination, some seedlings on each of sterilised and non sterilised beds were pricked out on to pricking out beds (which have undergone the same sterilisation procedure as the previous beds) and other seedlings were left on the nursery beds as non-pricked out seedlings. The procedure for pricking out and soil sterilisation followed the standard nursery practices recommended by Nyarko *et al.* (2010). In order not to cause damage to the seedlings, the leaves were held and dibber was used to remove them. Watering and shading of all seedlings were reduced gradually to harden seedlings for transplanting.

In the main experimental field, six plots each measuring 1.5×2.5 m were made in three replicates (blocks) giving a total of 18 plots. Four weeks after sowing, both the pricked out and non-pricked out plants from sterilized and non sterilized beds were transplanted in three rows on each plot at a spacing of 45×35 cm, giving a total plant population of 21 plants per plot. Agronomic practices such as watering, stirring, weed control, fertilization, disease and weed control were carried out to all plants in the same manner.

Data collection and analysis: Five plants of each treatment combination were randomly selected and tagged. The means of the following parameters were computed on the tagged plants to represent each plot: Plant height, number of leaves, number of branches, canopy spread, number of fruits per plant, fresh fruit weight and dry fruit weight. Data collected was subjected to Analysis of Variance (ANOVA) using GenStat statistical package and treatment means were compared using the Standard Error of the Difference (SED) at 5%.

RESULTS

For plant height, there was neither soil sterilisation X pricking out treatment interaction effect, nor significant sterilisation main effect. Therefore, the main effect of pricking out is presented (Fig. 1). Pricked out plants produced taller plants as compared to the non-pricked out ones.

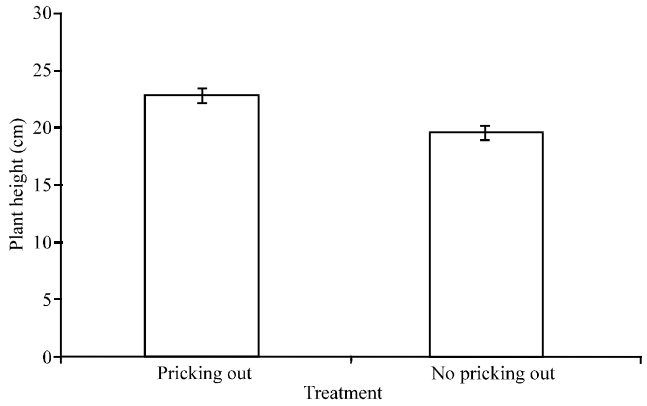

Fig. 1: Effect of pricking out on plant height, bars show standard error of the difference, n = 72, df = 46

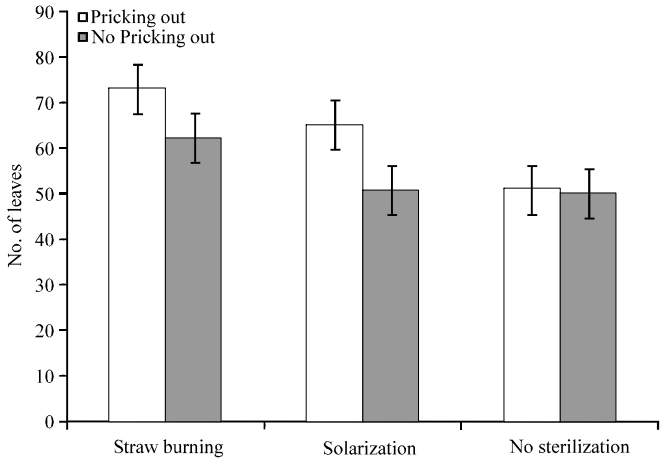

Fig. 2: Effect of pricking out and sterilization treatments on the number of leaves, bars show standard error of the difference, n = 54, df = 34

The soil sterilisation×pricking out interaction was significant ($p<0.05$) for the number of leaves (Fig. 2). For the sterilised beds, pricked out plants produced more leaves as compared to the non-pricked out ones. Results further showed that there was no ($p>0.05$) difference in the number of leaves between the pricked out and non-pricked out plants which were raised on unsterilized nursery beds. Among the non-pricked out plants, more leaves were obtained from those raised on beds which have been sterilized by straw burning.

Interaction effect of sterilisation types and pricking out on number of branches was not significant ($p>0.05$). The pepper plants produced branches only after the 6 weeks and the pricked out plants had more ($p<0.05$) number of branches under this study at 8 WAP as compared to those that were not pricked out (Fig. 3).

The results show no significant ($p<0.05$) differences in canopy spread between plants raised from beds with straw burning, solarisation and no sterilisation across all weeks (Fig. 4).

The sterilisation×pricking out interaction was not significant ($p>0.05$) as far as number of fruits and fresh and dry fruit weights were concerned. The main effects of sterilisation and pricking out which were significant are therefore, presented (Table 2, 3). The result revealed that plants

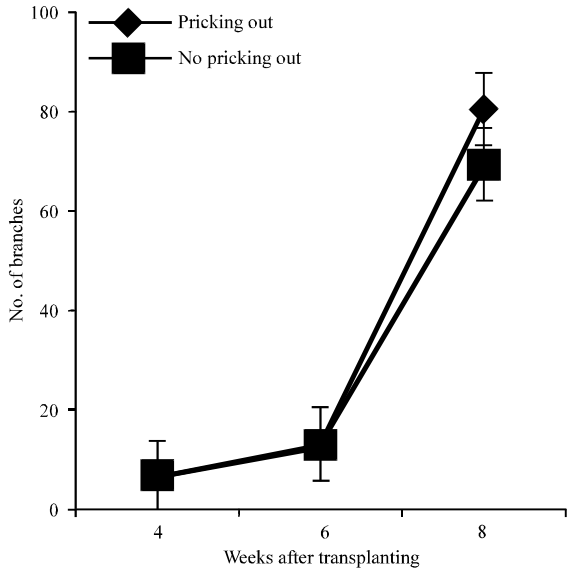

Fig. 3: Effect of pricking out on number of branches, bars show standard error of the difference, n = 54, df = 34

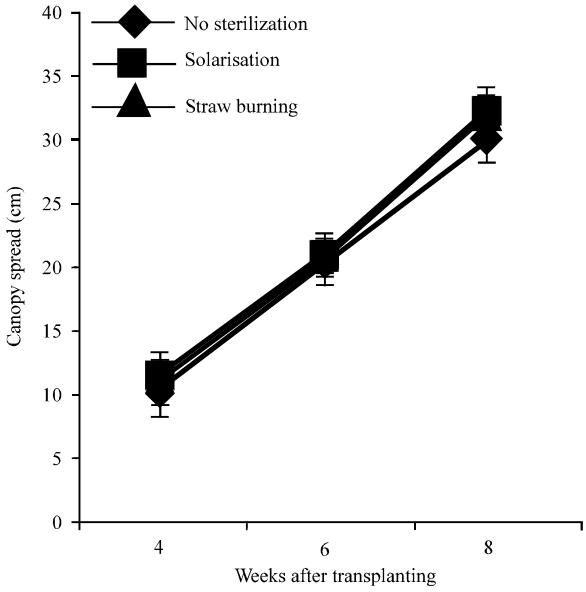

Fig. 4: Effects of soil sterilisation on canopy spread, bars show standard error of the difference, n = 54, df = 34

Table 2: Pricking out main effects on the number and fruit weights of chilli pepper

Treatment	No. of fruits per plant	Fresh fruit weight per plant (g)	Dry fruit weight per plant (g)
Pricking out	208.7	358.20	115.50
Non pricking out	107.7	170.90	61.30
SED	18.5	43.88	8.65
df	10.0	10.00	10.00
Replication	9.0	9.00	9.00

n = 18

Table 3: Sterilization main effects on the number and fruit weights of chilli pepper

Treatment	No. of fruits per plant	Fresh fruit weight per plant (g)	Dry fruit weight per plant (g)
Straw burning	172	337.5	107.4
Solarisation	183	261.2	88.4
No sterilisation	118	194.9	69.5
SED	22.22	24.12	10.59
df	10	10	10
Replication	6	6	6

n = 18

that were pricked out produced more number of fruits and higher fresh and fruit weights as compared to those that were not pricked out (Table 2). Likewise, sterilisation of nursery beds also performed better in all the fruit parameters studied (Table 3). Straw burning sterilization resulted in higher fresh and fruit weights of pepper as compared to solarisation.

DISCUSSION

Pricking out was more effective in promoting vegetative growth and development (plant height, number of leaves, number of branches and canopy spread). Obviously, this finding is in contrast with that of Sinnadurai (1992), who reported that *Capsicum frutescens* does not need pricking out. It was observed that pricking out led to more plant growth which resulted in taller plants and more number of branches per plant. This agrees with the findings of Bosland and Votava (2000) who reported that pricking out results in primary and secondary branching of the pepper plant. Pricking out reduces competition among pepper seedlings (intra species competition) for nutrient, water and light. Stiff competition for nutrient especially N, water and light might have caused stunted growth, physiological drought and etiolation in the early stages of the non-pricked out seedlings that resulted in their poor vegetative growth in the field. Moreover, overcrowding of seedlings and root hair disturbances during transplanting in the non-pricked out seedlings could have caused physiological shock and loss of tender leaves during transplanting (Nyarko *et al*., 2011). It was observed that pricking out plants were bigger in size and could have outgrown competing weeds (Jaenicke, 1999).

The effect of sterilisation (especially straw burning) was more pronounced on the number of leaves and canopy spread as compared to other growth parameters. This finding is in line with that of Handiseni *et al*. (2010) who reported that, burning organic materials on soil could raise soil temperatures in the first 10 cm of soil to more than 50°C whereas solarisation could only raised soil temperature in the first 5 cm to about 39°C. This means that the former could have controlled a wider range of pathogens and weed seeds as suggested by several authors (Kurt and Emir, 2004; Kiff *et al*., 2000; Jaenicke, 1999).

Again, straw burning and solarisation of nursery beds enhanced the number as well as the fresh and dry weights of fruits per plant as compared to the control. This may probably be attributed to roots of the plants being healthy and vigorous enough to absorb more nutrients for rapid growth and development which subsequently increased fruit weight per plant. In a similar studies, Cimen *et al*. (2012) found out that the content of macro nutrients were increased in leaves of tomato by solarisation which resulted in three times higher yield than the non-sterilised control. Pricking out influenced the yield independently as was reflected in the fruit parameters of pepper (number of fruits, fresh weight and dry weight of fruits). Pricking out resulted in more number of fruits and also higher fresh and dry weights of fruits. The number and weight of fruits of pepper

doubled when pepper plants were pricked out as compared to the non-pricked out plants. This is an indication of effective utilisation of available growth factors such as nutrient, water, space and light for the pricked-out plants. Increased number of leaves due to branching especially for the pricked out plants could have heightened photosynthetic activities. This could have increased flowering and ultimately enhanced carbohydrates accumulation resulting in higher number and weight of fruits.

CONCLUSION

Pricking out and sterilisation acting independently or in combination contributed to pepper growth and development as was reflected in the parameters studied. Soil sterilization especially straw burning enhanced the production of more leaves and higher fresh fruit weight per fruit. Pricked out plants were taller, produced more branches, produced about twice the number and weight of fruits compared to non-pricked out ones. As other form of nursery bed sterilisation such as use of fumigants and steam are more expensive and may be polluting the environment, resource poor farmers in the arid tropics should be encouraged to sterilise nursery soil by straw burning. Combination of nursery bed sterilisation and pricking out would improve farm sanitation, reduce competition for the scarce nutrient in the arid environment and quicken the establishment of pepper transplant.

It is recommended that nursery beds should be sterilised by either straw burning or solarisation before seeds are nursed and also the seedlings should be pricked out before transplanting. Ongoing research is quantifying the reduction in soil pathogen and weed seeds as a result of the nursery bed sterilization types under consideration.

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