AEXTJ
AGRICULTURAL EXTENSION JOURNAL
ISSN 2521 – 0408

Available Online at www.aextj.com
Agricultural Extension Journal 2018; 2(2):106-110

RESEARCH ARTICLE

Effect of Transplanting Age on the Growth and Yield of Green Pepper (*Capsicum annuum* L.) in Abakaliki Southeastern Agro-Ecological Zone of Nigeria

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Received: 25-03-2018; Revised: 01-05-2018; Accepted: 25-05-2018

ABSTRACT

A field experiment was conducted at the research farm of the Department of Crop Production and Landscape Mangement of the Faculty of Agriculture, Ebonyi State University, Abakiliki, in Southeasthern Agro-ecological zone of Nigeria for a period of 8 weeks to study the effect of transplanting age on growth and yield of green pepper, laid out in a randomized complete block design in four replicates. The agronomical characteristics that were measured were as follows: Plant height, number of leaves per plants, days to 50% flowering, number of fruit per plot, and weight of fruit per plot (kg/plot). The result of the field trial showed that transplanting age had a significant effect only on plant height at 8 weeks of age of transplanting. The other vegetative parameters such as number of branches, number of leaves, and 50% flowering and field component such as number and weight of fruits were not affected by the transplanting age. Therefore, the best age to transplant green pepper is from 1 to 7 weeks, for optimum performance.

Key words: Crop production, green pepper, Nigeria, transplanting age

INTRODUCTION

Green pepper (*Capsicum annuum* L.) belongs to the family Solanaceae which also includes tomato, tobacco, eggplant, and Irish potato. It is one of the most varied and widely food condiments in the world.[1] Green pepper is originated from Mexico and Central America regions. Christopher Columbus encountered pepper in 1493, and because of its pungent smell, he thought it was related to black pepper, *Piper nigrum,* which is actually a different genus. Nevertheless, the name stuck and the crop was introduced to Europe, and was later spread to Asia and Africa. Many of the early uses of green pepper centered on medicinal purposes, and the crop has been credited with a number of useful cures and treatments, some of which are valid and some of which are probably more of folklores.[1]

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The green pepper is an erect plant with branching stems which may attain heights of 50–80 cm. Green peppers are considered a self-pollinating crop although some outcrossing will occur. Although it is grown as an annual crop due to its sensitivity to cold, green pepper is an herbaceous perennial crop that will survive and yield for several years in tropical climates. When grown in deep homogenous soils, it develops a root system that may extend to a depth of 40 and 70 cm. Virtually, every country produces green pepper and its production has increased in recent years worldwide.[2] That could be at least in part because of the high nutritional value of this species. One green pepper, according to Kelly and Boyhan,[1] can produce up to 8% of the recommended daily allowance of Vitamin A, 180% of Vitamin C, 2% of calcium, and 2% of iron; in addition, pepper contains significant amount of A and B Vitamins.
In Nigeria, green pepper is one of the vegetable crops that are grown on large scales in the northern part of Nigeria. The production of this crop in Eastern Nigeria is largely in the hands of

smallholder farmers who may not be well informed on some well cultural practices that can promote production of this crop, such as the appropriate age of transplanting the seedlings, the right quantity of fertilizer to apply, and technologies for combating soil acidity and other fertility problems. Ogbodo reported that these have resulted in low yield and exorbitant prices per unit weight of the fruit in the area.[3]

Transplanting or indirect seedling is the process of growing seedlings in a greenhouse or other controlled environment before placing plants outdoors. The plants are grown in a protected environment until they are of the right size or the right weather is optimal and they grow to maturity.[4] Conversely, Vantenem and Verlindens (2003) reported that transplants are not always a favored method of establishing crops in a field. This depends on the type of vegetable that is being planted, the kind of environment the transplants will be grown and the economic returns that may be expected from the exercise. The effect of transplant age on yield is an issue often broached by growers of agronomic and horticultural crops in an effort to maximize production potential. Despite general interest in this area, the literature is surprisingly sparse.[5]

Agronomic interest in transplant age is most prominent in rice (*Oryza sativa* L.), a bare-root transplanted crop of major economic importance. Transplant age studies have also been conducted on tobacco *Nicotiana tabacum* L., cotton *Gossypium hirsutum* L., rape *Brassica napus* L., and forest species.[6-11] The largest volume of literature on transplant age is on vegetables.[12] Vavrina suggested ages for field planting for numerous vegetable transplants.[5] These recommendations are generally based on years of horticultural observations and research. However, the scientific investigation of vegetable transplant age is far from complete. The objectives of this study, therefore, are to evaluate the effect of various transplanting ages on the growth and yield of green pepper and to determine the best transplanting age for this crop.

MATERIALS AND METHODS

The field experiment was conducted at the research farm of the Department of Crop Production and Landscape Management of the Faculty of Agriculture and Natural Resources management, Ebonyi State University, Abalikiliki, in the Southeast Agro-ecological zone of Nigeria for a period of 18 weeks. The experimental field is located on the globe at latitude $6^0$19'407''N, longitude $8^0$7' 832"E of the equator, and at an altitude of about 447 m above sea level. The annual rainfall is about 2060 mm spread between April and October with a slight break in August (August break).

Experimental design and field design

The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatment comprised of 7 transplanting ages (1–7 weeks after germination). The experimental field measured 18 m × 12 m width, which gave a total land area of 216 m^2. The experimental field was divided into four equal blocks that were separated by 1 m alley. Each block consisted of seven plots giving a total of 28 test plots, each measuring 2 m × 2 m with 0.5 between adjacent plots.

Nursery soil preparation and seedling establishment

Topsoil samples were collected from the experimental field of the Faculty of Agriculture and Natural Resources Management and mixed with river sand and composted poultry manure at a ratio of 3:2:1. The mixture was sterilized using wood fire. Seedboxes were used to raise the pepper seedling. The nursery was set up on May 17, 2015. The seeds were lightly sprinkled in rows and lightly covered. Watering of the seed beds and seedlings were twice daily (morning and evening). This continued until the end of transplanting period.

Land preparation and transplanting

The experimental site of land area = 18 m × 12 m (216 m^2) was manually cleared and raised field beds of 2 m × 2 m (plot area = 2 m × 2 m 4 m^2). Space between each block = (1 m^2) and spacing between plot = (0.5 m) were made on May 14, 2015, for the first transplant. Subsequent beds were made a day before planting. The seedling were transplanted into the field beds at 7 transplanting ages of 1–7 weeks after germination respectively. The plant spacing of 60 cm × 50 cm was used. This gave a total of 12 stands per plot.

Fertilizer application, mulching, weed control, and harvesting

Basal application of NPK (15:15:15) fertilizer was applied at 2 weeks after each of the seven consecutive transplant ages. Rice husk was used as mulching materials which was spread on each bed before transplanting. Weeds were controlled using hoes as often as necessary to keep the plots free from weeds. Harvesting of the pepper fruits commenced from the 11th week after the first transplant age and 12 weeks after sowing in the nursery, respectively. This was done manually by hand picking.

Measurement of vegetative and yield components

The plant height of four middle-tagged plants per plot was measured. The primary (main) stem was measured from the base of the plant to the apex 2 weeks before the first harvests for the various transplanting ages using meter rule. The number of branches produced per four-tagged plants per plot was counted 2 weeks before the first harvesting of the fruits and average number recorded. The number of leaves produced per four middle-tagged plants per plot was counted before the first harvesting of the fruits and average number recorded. Days to 50% flowering were recorded at the time when half of the plant in each plot flowered.

The number of fruits harvested per three middle-tagged plants per plot was counted at each harvest for 3 times. These were added up and average number recorded. Fruits from the four middle tagged plants per plot were weighed at each harvest for 3 times, using weighing balance. These were added up and the average fruit weight per plot computed.

Statistical analysis

Statistical analysis of the data collected was done following the procedure for a RCBD for a two-way analysis of variance as outlined by Steel and Torrie.[13] Separation of treatment means for the significant difference was done by the use of Fisher's least significant difference as described by Obi.[14]

RESULTS

Effects of transplanting age on plant height, number of branches, and leaves

The result as presented in Table 1 showed that transplanting age had a significant difference ($P < 0.05$) at 8 weeks after planting. The tallest plants were produced when the transplants were 1 week in the nursery which was statistically similar to that of transplanting ages of 2 and 5 weeks. No significant difference existed in all other weeks after planting. As the number of weeks after transplanting (WAT) increased from 2 to 8 weeks, the plant height generally increased. The result in Table 2 showed that transplanting age had no significant effects on the number of branches produced at 2, 4, 6, and 8 WAT. However, the number of branches produced increased from 2 to 8 weeks. The result showed that transplanting age had no significant effect on the number of leaves produced at 2, 4, 6, and 8 WAT [Table 3]. However, the number of leaves produced increases as the week increased from 2 to 8 weeks.

Effect of transplanting age on 50% flowering, average number of fruits, and average weight of fruits (kg/plots)

The results in Table 4 indicated that the number of days required for the 50% of the plant to flower, was not affected by the transplanting age of the plant. Furthermore, average number of fruits and weight of the fruits were not affected by transplanting age.

DISCUSSION

The result of this field trial showed that transplanting age had significant effects only on the plant height produced at 8 WAT [Table 1]. The vegetative parameters such as number of branches [Table 2], number of leaves [Table 3], and yield components such as 50% flowering [Table 4] number and weight of fruits [Table 4] were not affected by the transplanting age. This result was in agreement with the findings of McCraw and Greig[15] using 8- and 11-week-old transplants of four cultivars in a green pepper transplant age study in Kansas. Pooling the data from the four cultivars, they found no differences due to transplant age in early yield (number and weight) in the 1st year, but a greater number of heavier fruits with 8-week-old transplants the following year. Vavrina and Armbrester conducted a 1-year trial in Florida with a transplant of age of 4, 6, and 11 weeks.[16] They found no effect of transplant age on yield (number and weight) in three of four harvests, but a significant yield increases at fourth harvest with

Table 1: Effect of transplanting age on plant height (cm) at 2, 4, 6, and 8 WAT

Transplanting age (weeks)	Weeks after planting			
	Week 2	Week 4	Week 6	Week 8
1	8.39	14.00	18.96	21.72
2	8.73	11.29	17.21	23.66
3	8.17	9.83	14.33	21.27
4	8.01	10.84	13.50	20.79
5	7.72	11.21	15.97	23.29
6	7.63	7.62	14.88	20.26
7	7.74	8.12	13.38	20.74
Mean	8.06	10.42	15.46	22.10
F-LSD (0.05)	ns	ns	ns	2.36

Key: NS: Not significant. F-LSD: Fisher's least significant difference, WAT: Weeks after transplanting

Table 2: Effect of transplanting age on number of branches at 2, 4, 6, and 8 WAT

Transplanting age (weeks)	Weeks after planting			
	Week 2	Week 4	Week 6	Week 8
1	2.17	2.76	4.00	4.25
2	2.18	2.42	3.57	5.25
3	2.33	2.57	3.00	4.25
4	2.08	2.33	4.00	4.00
5	1.92	2.74	3.50	4.25
6	2.25	2.43	3.82	3.57
7	2.08	2.42	3.57	4.00
Mean	2.23	2.44	3.64	4.22
F-LSD (0.05)	ns	ns	ns	ns

Key: NS: Not significant. F-LSD: Fisher's least significant difference, WAT: Weeks after transplanting

Table 3: Effect of transplanting on number of branches at 2, 4, 6, and 8 WAT

Transplanting age (weeks)	Weeks after planting			
	Week 2	Week 4	Week 6	Week 8
1	8.17	12.17	23.91	34.25
2	6.83	12.50	22.92	33.33
3	8.08	12.00	24.08	34.00
4	8.50	12.09	23.50	31.50
5	6.92	11.00	22.00	33.42
6	7.25	10.25	22.25	34.42
7	7.75	11.00	24.11	34.88
Mean	7.64	11.57	23.25	33.89
F-LSD (0.05)	ns	ns	ns	ns

Key: NS: Not significant. F-LSD: Fisher's least significant difference, WAT: Weeks after transplanting

Table 4: Effects of transplanting age days to 50% flowering, average number, and weight of fruits/plot

Transplanting age (weeks)	Days to 50% flowering	Average number of fruits/plot	Average weight of fruits (kg)/plot
1	75.8	7.25	0.450
2	74.2	6.75	0.500
3	78.2	6.50	0.525
4	71.8	7.00	0.560
5	81.5	6.25	0.685
6	82.8	6.50	0.475
7	74.8	6.00	0.475
Mean	77.00	6.61	0.531
F-LSD (0.05)	ns	ns	ns

Key: NS: Not significant. F-LSD: Fisher's least significant difference

4-week-old transplants. The yield effect here was due to a greater number of fruits rather than due to greater individual fruit weight. McCraw and Greig[15] observed a similar finding with 11-week-old transplants. Three of the studies cited here imply that pepper transplant of 8–11 weeks may have a yield advantage for early, size, and number of fruits[15-17] and were under quite different environments, which makes comparisons among the studies difficult. Perhaps, a standardization of the number of harvests for early and total yield is necessary to critically determine the impact of transplant age on green pepper production.

The result of this experiment was studied under seven different transplanting ages such as 1–7 weeks which was carried out at research farm of the Department of Crop Production and Landscape Management, Ebonyi State University, Abakiliki. In general, rice husk was used as crop production measures to mulch the bed so as to ensure that total moisture is maintained to enable the plant to survive and to as to avoid drying off of the leaves. This was found to be highly effective in moisture conservation. Transplanting green pepper from 1 to 3 weeks was suitable transplanting time, because during this stage, the plant can easily withstand shock due to transplanting, without shedding its leaf. Green pepper transplanting at these ages thrives faster more than the ones transplanted from 4 to 7 weeks. Green pepper transplanted from 4 to 7 weeks can hardly withstand shock, and if care is not taken, all the leaves will completely drop off, especially the ones at 6 and 7 weeks. At this age, the plant may have already started flowering and when transplanted to the field will shed its leaves and its flowers may abort. Hereby making it impossible for the green pepper plant to fruit well and at times, it will be stunted. In this work, there is no great difference between green pepper transplanting ages except on plant height produced at 8 WAT. The other vegetative parameters were not affected by transplanting age.

CONCLUSIONS AND RECOMMENDATIONS

Since transplanting age had significant effect on plant weight only, I therefore recommend that farmers should use Green pepper transplant of 1–7 weeks old for planting on their farms to ensure adequate yield so as to enhance improved production because transplanting of green pepper from the 1–7 weeks from the nursery farm to its permanent place on the field will make the green pepper to withstand shock and also there will be no leaves, thereby increasing its productivity.

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