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Article

Measuring the Influence of Seedling Age and Nutrient Sources on the Performance of Sweet Corn (*Zea mays* L.) under Temperate Climatic Conditions

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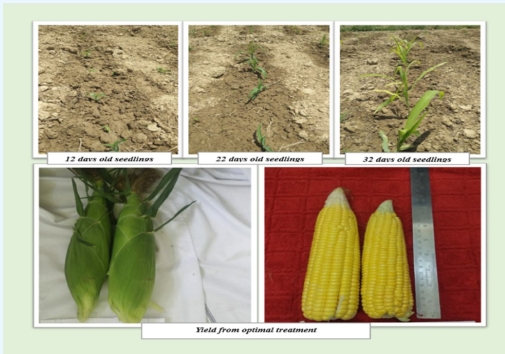

ABSTRACT: An experiment was conducted to evaluate the effect of the age of a seedling and sources of nutrients on the growth and yield of sweet corn at SKUAST-K during Kharif-2020. The experiment was performed under a factorial arrangement in a randomized complete block design (RCBD) with three replications. Factor A was the age of the seedling with three levels, *viz.*, 12-day-old seedlings, 22-day-old seedlings, and 32-day-old seedlings. Factor B was the source of nutrients with five levels, *viz.*, control, recommended dose of fertilizer (RDF), 1/2 RDF + 12 t ha^{-1} farmyard manure, 1/2 RDF + 4 t ha^{-1} vermicompost, and 1/2 RDF + 2 t ha^{-1} poultry manure. The experiment was tested using variety Sugar-75 with a spacing of 75 × 20 cm^2. The findings of this study indicated that the age of the seedling and sources of nutrients extended a significant influence on growth parameters, yield attributes, and yield of sweet corn. Significantly highest values for various growth parameters of sweet corn, *viz.*, plant height, number of functional leaves, leaf area index (LAI), and dry matter accumulation from 30 days after transplanting up to the harvest, were noted by transplanting A_2 seedlings (22 day old). A similar trend was observed for yield attributes and yield with higher values with transplanting A_2 seedlings (22 day old). Plots fertilized with 1/2 RDF + 2 t ha^{-1} poultry manure registered a significantly higher plant height, leaf area index (LAI), dry matter accumulation, and number of functional leaves, which eventually resulted in a higher green cob yield and green fodder yield under the same treatment. Overall, this study indicated that among different ages of seedlings, transplanting A_2 seedlings (22 day old) outperformed other seedling ages, and plots treated with 1/2 RDF + 2 t ha^{-1} poultry manure outperformed other treatments; a combination of both proved superior in realizing a higher yield and profitability with a benefit−cost ratio (BCR) of 6.57 under temperate climatic conditions.

■ INTRODUCTION

Sweet corn is a warm-season, frost-sensitive crop with a preferred growing temperature of 15−32 °C. This crop adapts to temperate climates though it usually is affected by weak seed vigor and poor emergence rates.[1] Despite the desirable quality attributes of *sh*-2, *se*-1, and other endosperm genotypes, reduced field emergence and seedling vigor hinder their utilization.[2,3] Reduced stand uniformity results in heterogeneous ear maturity and a reduced yield and value. It was advocated that transplanting maize under late sowing conditions might be a viable alternative to direct sowing.[4] Transplanting maize helps farmers to accommodate more than one crop in a year, as the growth period of maize was found to be reduced by 8−10 days by transplanting.[5] Transplanting advantages in a number of ways, which include the optimum use of seed and space, reducing the risk associated with early vegetative growth at a slow rate, and ensuring uniform crop stand, which eventually leads to more uniform flowering and enhanced yields.[6] Thus, transplanting can be considered as a prominent effort to promote the earliness of the crop and exploit the production potential of different crops to the maximum. Transplanting technology is competent if a suitable age of the transplant is chosen[7] and the appropriate age of seedlings positively influences crop growth, yield, and quality.[8] It was opined that beyond 21-day-old seedling, the grain yield of maize reduced gradually[9] and a similar grain yield as that of the direct-seeded crop is realized by transplanting 21-day-old seedlings.[5] Besides, transplanting also prevents severe damage caused by birds that feed on the dibbed grains and emerging cotyledons/seedlings and helps to maintain optimum plant stand. In spite of

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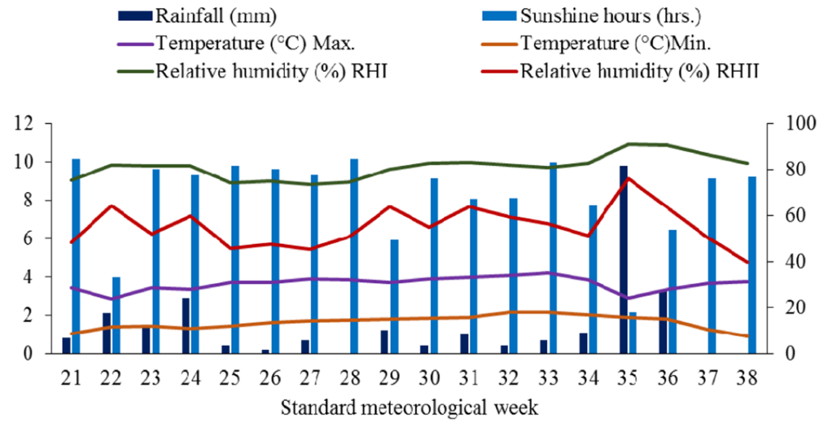

Figure 1. Mean weekly meteorological parameters during Kharif-2020.

humongous consideration in this area, little information is available regarding the optimum age of seedling. Growing transplanted sweet corn with proper information regarding the standardized age of the seedling can benefit the farmers and can act as an alternative to direct sowing. Declining crop yields corresponding to increasing soil degradation is creating an alarming situation to emphasize sustainability in agriculture concerning the maintenance of soil fertility and stabilization of crop productivity as one of the major concerns. It is apparent that with soil nutrient depletion, either in the form of nutrient losses or plant consumption, a huge demand is generated for nutrient replenishment, and fertilizers are used to replenish the nutrient loss. However, to achieve production targets, the increasing cost of fertilizers is considered a major check coupled with its deleterious effect on the soil and environment. The use of organic sources of nutrients is a healthy attempt for the maintenance of healthy soils and gives a boost to production. Addition of organic manures exerts an appreciable influence on the physicochemical as well as biological properties of the soil, thereby on sustainable crop production.[10] However, to meet the country's requirement of food grains and other agricultural commodities needed for the projected population, the available organic sources of nutrients such as animal waste, crop residue, and household waste are not enough to fulfill the demand. Therefore, the balanced use of organic and chemical fertilizers to complement each other in sustaining crop production is a prime requisite. This experiment was conducted with the aim of finding the perfect and suitable seedling age coupled with integrated nutrient sources for attaining efficient production of sweet corn under a temperate climate.

MATERIALS AND METHODS

Experimental Site Description. A field investigation was conducted to study the performance of sweet corn in terms of growth and yield influenced by seedling age under different sources of nutrients during Kharif-2020 at the Faculty of Agriculture SKUAST-K, Wadura, J&K. During the period of study, relevant weather data was collected from the Meteorological Observatory located at Shalimar. It was noted from the data that weekly minimum and maximum temperatures ranged from 7.5 to 18.1 °C and 23.8 to 35 °C, respectively, with 166 mm of rainfall during the season, as shown in Figure 1. Soil analysis of the experimental site done before transplanting sweet corn showed a silty clay loam texture of soil with a neutral reaction. With respect to available NPK, the soil was found to be medium, as given in Table 1.

Table 1. Initial Soil Physicochemical Properties of the Experimental Field

s. no.	parameter	value	remark
1	pH	6.67	neutral
2	electric conductivity	0.36 dS m^{-1}	normal
3	organic carbon	0.71%	medium
4	bulk density	1.32 g cm^{-3}	
5	texture	silty clay loam	
6	available nitrogen	304.67 kg ha^{-1}	sufficient
7	available phosphorus	17.20 kg ha^{-1}	sufficient
8	available potassium	181.50 kg ha^{-1}	sufficient

Experimental Design. The experiment consisted of two factors with three levels of factor A: age of the seedling and five levels of factor B: nutrient sources. The age of the seedling consisted of A_1: 12-day-old seedlings, A_2: 22-day-old seedlings, and A_3: 32-day-old seedlings. Nutrient sources consisted of F_0: control, F_1: recommended dose of fertilizer (RDF), F_2: 1/2 RDF + 12 t ha^{-1} FYM, F_3: 1/2 RDF + 4 t ha^{-1} vermicompost, and F_4: 1/2 RDF + 2 t ha^{-1} poultry manure. The design executed was a randomized complete block design with a factorial arrangement consisting of three replications.

Experimental Details. The seedlings of sweet corn were raised in polybags, and the sowing was done in three intervals at a gap of 10 days to achieve seedlings of the required age, *i.e.*, 12-day-old seedlings, 22-day-old seedlings, and 32-day-old seedlings ready on the same date. The polybags were placed in a greenhouse, and cultural operations were done regularly. The land was configured for the transplantation of seedlings by opening furrows (row) at 75 cm with a 20 cm intrarow spacing. The seedlings were transplanted to the experimental field carefully so that their root system was not disturbed for effective seedling establishment.

Observations Recorded. *Seedling Quality Parameters.* The shoot and root length of the five randomly selected seedlings were measured in centimeters from each set of seedlings. The measured shoot and root length were used to calculate the root and shoot ratio by dividing the seedling root length with its respective shoot length. These representative seedlings were used for the determination of fresh and dry weight. The seedling vigor I and II was calculated by using the below equations

$$\text{seedling vigor I} = \text{germination percentage} \times \text{seedling length}$$

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$$\text{seedlingvigor II} = \text{germination percentage} \times \text{seedling dry weight}$$

Germination Percentage. After the sowing of seeds in known no. of polybags, the number of germinated seeds was counted. The germination percentage was calculated using the given formula

$$\text{germination (\%)} = \frac{\text{number of germinated seeds}}{\text{total number of seeds}} \times 100$$

Growth and Yield Attributes. Five randomly selected plants were tagged from the net plot and were used for recording the plant height, number of functional leaves, and leaf area index (LAI) at 15 day intervals after transplanting and at harvest. The average was calculated and recorded from each experimental unit. The total number of cobs of the tagged plants was counted and expressed as the average number of cobs per plant. The average length measured from the base to tip of the cob and circumference of the harvested cobs of observational plants were computed as the cob length and the cob girth, respectively. Likewise, the average weight of the harvested cobs of observational plants with and without husk was computed as cob weight. The weight of fresh cobs from the net plot was recorded after harvest and expressed as q ha^{-1}. After the picking of cobs, the green fodder yield was recorded by cutting the plants near the ground surface and weighed as kg plot-1 and expressed as q ha^{-1}.

Statistical Analysis. For analyzing the data statistically, analysis of variance subjected to randomized complete block design (factorial) was done with the help of R software (R Core Team, 2013). A critical difference (CD) test was used to check the significant difference among treatment means at a 0.05 level of probability. Boxplot analysis of LAI at flowering, plant height at harvest, and dry matter production at harvest and yield was done using R software.[11]

RESULTS

Seedling Parameters. The age of seedlings had a significant impact on seedling parameters, *viz.*, seedling shoot length, seedling root length, root/shoot ratio, seedling fresh weight and dry weight, and seedling vigor I and II. As it is evident that with the increasing age of the seedling, the values for these parameters increased as they got ample time for growth and development. Table 2 shows that the maximum shoot and root lengths of 34.57 and 26.79 cm, respectively, were attained under 32-day-old seedlings and the minimum shoot and root lengths of 8 and 13.71 cm, respectively, were attained under 12-day-old seedlings. The 12-day-old seedlings recorded a higher root/shoot ratio of 1.82 as compared to the 22-day-old seedlings, which recorded a lower root/shoot ratio of 0.76. The highest seedling fresh and dry weights of 3.38 and 1.13 g, respectively, were observed under 32-day-old seedlings and the lowest fresh and dry weights of 1.06 and 0.06 g, respectively, were noted under 12-day-old seedlings. However, no significant difference was observed with respect to germination percentage, which may be due to the presence of similar environmental conditions in the greenhouse. The germination percentage ranged from 93.6 to 94.7%. Seedling vigor I and II was significantly influenced by the age of the seedling, with the highest seedling vigor I (5811.57) and II (107.46) under 32-day-old seedlings and the lowest seedling vigor I (2030.86) and II (4.85) under 12-day-old seedlings.

Table 2. Seedling Quality Parameters of Sweet Corn Influenced by Seedling Age[a]

age of seedling (days)	fresh weight (g)	dry weight (g)	shoot length (cm)	root length (cm)	root/shoot	germination (%)
A_1: 12	1.06	0.06	8	13.71	1.82	93.57
A_2: 22	2.33	0.39	19.34	14.71	0.76	94.50
A_3: 32	3.38	1.13	34.57	26.79	0.78	94.71
SE(m)±	0.24	0.11	1.25	1.05	0.12	0.69
CD ($p \leq 0.05$)	0.76	0.33	3.88	3.26	0.38	NS

age of seedling (days)	seedling vigor I	seedling vigor II	nitrogen content (%)	phosphorus content (%)	potassium content (%)
A_1: 12	2030.86	4.85	0.11	0.07	0.11
A_2: 22	3221.02	36.67	0.16	0.12	0.17
A_3: 32	5811.57	107.46	0.21	0.18	0.21
SE(m)±	187.44	10.14	0.01	0.02	0.02
CD ($p \leq 0.05$)	583.95	31.58	0.04	0.06	0.07

[a]CD = critical difference.

Growth Parameters. Sowing dates had a substantial impact on the crop's dry matter production. Growth parameters showed a significant variation with respect to age of seedlings (Table 3). Transplanting A_3 seedlings (32 day old) recorded the highest plant height up to 30 days after transplanting. Thereafter, A_2 seedlings (22 day old) performed better and registered the maximum height up to the harvest with a significant difference (Figure 2). The age of seedlings unequivocally had a positive impact on the number of functional leaves $plant^{-1}$ and leaf area index (LAI) of sweet corn (Tables 4 and 5). The highest number of functional leaves of 11.39 was recorded in 22-day-old seedlings and the lowest number of functional leaves of 10.65 was recorded under 32-day-old seedlings at 75 DAS. Transplanting 32-day-old seedlings recorded the maximum leaf area index at 15 and 30 DAT. Thereafter, 22-day-old seedlings were found to be significantly superior over the rest of the treatments up to the harvest, followed by 12-day-old seedlings. The highest value of 5.56 of LAI was recorded in 22-day-old seedlings and the lowest value of 4.87 was recorded under 32-day-old seedlings at 75 DAT (Figure 3).

Among various treatments of nutrient sources, no fertilizer application resulted in the least performance of sweet corn. Treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) recorded statistically higher results for the plant height, number of functional leaves, and LAI followed by treatment F_1 (RDF). These findings indicated that as the crop growth progressed, the number of functional leaves increased, and the maximum number of functional leaves was recorded at 75 DAT (at silking) and decreased thereafter. The highest number of functional leaves of 11.83 was obtained under the application of 1/2 RDF + 2 t ha^{-1} poultry manure and the lowest value of 9.93 under control at 75 DAS. The maximum value of LAI of 5.82 was obtained under the application of 1/2 RDF + 2 t ha^{-1} poultry manure at 75 DAT. Application of F_3 (1/2 RDF + 2 t ha^{-1} vermicompost) and F_2 (1/2 RDF + 2 t ha^{-1} FYM) (on an N-equivalent basis) was found at par with respect to the production of functional leaves and LAI. Boxplot analysis for LAI at flowering and plant height at the harvest is shown in Figure 3. A similar trend was noted for dry matter accumulation with treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure), producing

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Table 3. Plant Height of Sweet Corn Influenced by Seedling Age and Nutrient Sources[a]

treatments	plant height (cm)						
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	at harvest
Age of Seedling (days)							
A_1: 12	33.41	51.45	92.80	162.11	182.63	193.75	196.50
A_2: 22	37.81	57.43	99.61	180.76	198.37	211.42	214.41
A_3: 32	41.19	61.76	85.74	154.74	177.56	191.75	194.21
SE(m)±	0.96	1.26	1.60	2.45	3.42	4.67	5.00
CD ($p \leq 0.05$)	2.90	3.78	4.63	7.35	10.28	13.83	14.77
Sources of Nutrients							
F_0: Control	34.04	48.75	84.38	149.74	171.57	185.68	188.41
F_1: RDF	39.16	59.62	95.49	173.29	191.50	204.22	206.96
F_2: 1/2 RDF + 12 t ha^{-1} FYM	35.48	54.13	90.20	163.32	184.24	196.92	199.66
F_3: 50% RDF + 4 t ha^{-1} VC	35.81	55.37	91.14	162.64	184.24	198.58	201.31
F_4: 50% RDF + 2 t ha^{-1} PM	42.83	66.51	102.37	180.36	199.38	209.46	212.19
SE(m)±	1.07	1.39	2.06	2.38	3.15	6.81	3.93
CD ($p \leq 0.05$)	3.22	4.18	5.98	6.90	9.14	11.40	11.39

[a]CD = critical difference.

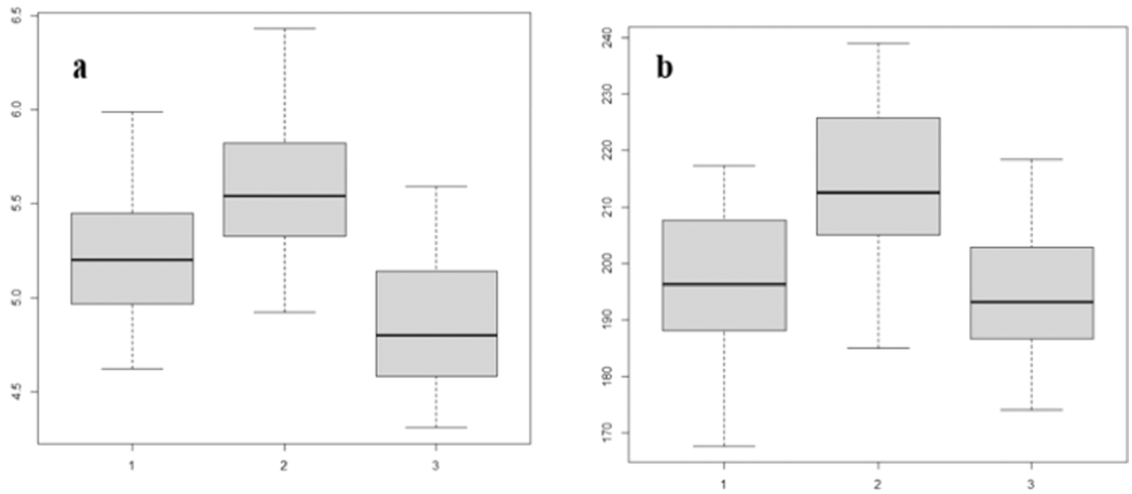

Figure 2. Boxplot showing variations in (a) LAI at flowering and (b) plant height at the harvest of three seedling ages (1: 12 day old; 2: 22 day old and 3: 32 day old).

Table 4. Functional Leaves of Sweet Corn Influenced by Seedling Age and Nutrient Sources[a]

treatments	number of functional leaves					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Age of Seedling (days)						
A_1: 12	5.77	6.75	9.19	10.25	10.65	8.16
A_2: 22	6.43	7.61	9.39	10.89	11.39	8.86
A_3: 32	6.68	8.11	8.45	9.19	9.93	7.56
SE(m)±	0.10	0.11	0.07	0.12	0.17	0.11
CD ($p \leq 0.05$)	0.26	0.33	0.18	0.37	0.49	0.29
Sources of Nutrients						
F_0: Control	5.09	6.42	8.16	8.90	9.44	7.10
F_1: RDF	6.72	7.88	9.51	10.58	11.20	8.59
F_2: 1/2 RDF + 12 t ha^{-1} FYM	6.24	7.37	8.56	9.91	10.32	8.00
F_3: 50% RDF + 4 t ha^{-1} VC	6.32	7.43	8.66	9.99	10.48	8.06
F_4: 50% RDF + 2 t ha^{-1} PM	7.07	8.34	10.18	11.16	11.83	9.21
SE(m)±	0.12	0.15	0.12	0.18	0.217	0.15
CD ($p \leq 0.05$)	0.37	0.42	0.33	0.51	0.61	0.44

[a]CD = critical difference.

the highest results with a significant difference followed by F_1 (RDF).

Yield Attributes. Data belonging to various yield attributes, as illustrated in Table 6, showed no significant difference among

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Table 5. Leaf Area Index of Sweet Corn Influenced by Seedling Age and Nutrient Sources[a]

treatments	leaf area index					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
Age of Seedling (days)						
A_1: 12	0.21	1.37	2.63	4.41	5.24	3.42
A_2: 22	0.26	1.60	2.85	4.66	5.56	3.86
A_3: 32	0.33	1.79	2.45	4.22	4.87	2.90
SE(m)±	0.004	0.009	0.036	0.031	0.041	0.021
CD ($p \leq 0.05$)	0.010	0.025	0.104	0.072	0.132	0.073
Sources of Nutrients						
F_0: Control	0.16	1.37	2.21	4.07	4.72	2.89
F_1: RDF	0.31	1.66	2.78	4.57	5.40	3.57
F_2: 1/2 RDF + 12 t ha^{-1} FYM	0.22	1.43	2.47	4.31	5.07	3.24
F_3: 50% RDF + 4 t ha^{-1} VC	0.23	1.47	2.53	4.36	5.11	3.28
F_4: 50% RDF + 2 t ha^{-1} PM	0.40	2.00	3.22	4.83	5.82	3.99
SE(m)±	0.005	0.011	0.046	0.030	0.064	0.044
CD ($p \leq 0.05$)	0.013	0.033	0.134	0.094	0.182	0.112

[a]CD = critical difference.

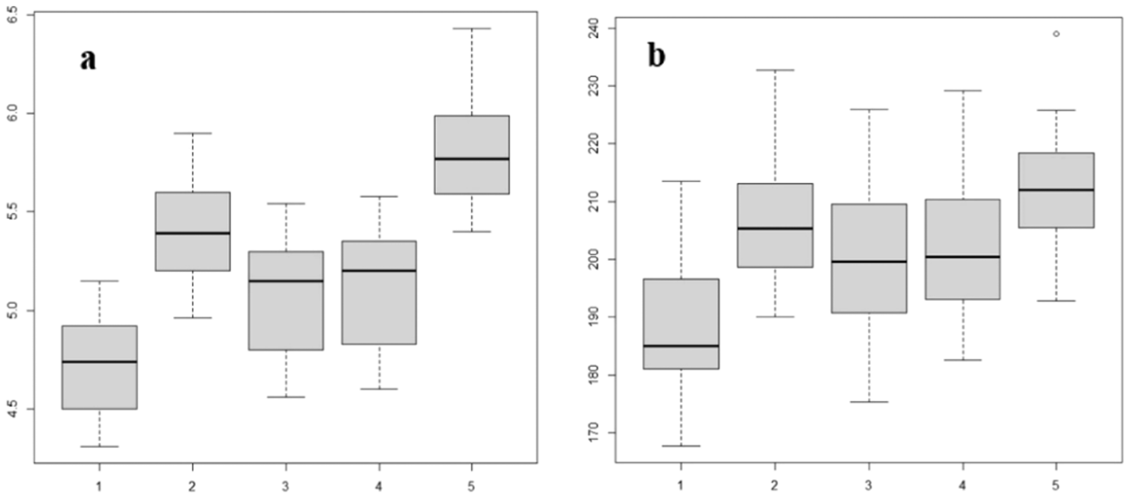

Figure 3. Boxplot showing variations in (a) LAI at flowering and (b) plant height at the harvest due to five nutrient sources (1: control; 2: RDF; 3: 1/2 RDF + 12 t ha^{-1} FYM; 4: 1/2 RDF + 4 t ha^{-1} vermicompost; and 5: 1/2 RDF + 2 t ha^{-1} poultry manure).

Table 6. Yield Attributes of Sweet Corn Influenced by Seedling Age and Nutrient Sources[a]

treatments	cob girth (cm)		cob length (cm)		cob weight (g)		no. of cobs plant^{-1}
	with husk	without husk	with husk	without husk	with husk	without husk	
Age of Seedling (days)							
A_1: 12	17.89	13.67	28.64	20.88	356.43	267.47	1.35
A_2: 22	19.06	15.62	29.69	21.70	373.53	287.03	1.41
A_3: 32	16.80	12.63	27.71	19.57	345.92	244.23	1.29
SE(m)±	0.23	0.15	0.212	0.16	4.35	3.35	0.01
CD ($p \leq 0.05$)	0.66	0.42	0.62	0.46	12.61	9.72	NS
Sources of Nutrients							
F_0: Control	15.46	13.13	25.93	19.07	244.94	206.11	1.23
F_1: RDF	18.75	14.26	29.42	21.36	397.52	284.11	1.41
F_2: 1/2 RDF + 12 t ha^{-1} FYM	17.78	13.64	28.64	20.55	359.50	264.67	1.33
F_3: 50% RDF + 4 t ha^{-1} VC	17.92	13.74	28.66	20.61	369.39	267.72	1.34
F_4: 50% RDF + 2 t ha^{-1} PM	19.68	15.10	30.75	22.00	421.80	308.61	1.44
SE(m)±	0.28	0.19	0.25	0.20	5.62	4.33	0.01
CD ($p \leq 0.05$)	0.83	0.54	0.74	0.62	16.28	12.56	0.03

[a]CD = critical difference.

different ages of seedlings with respect to the number of cobs per plant; however, other parameters, *viz.*, cob length, cob girth, and cob weight, showed a statistical difference. Transplanting A_2 seedlings (22 day old) recorded a higher value for the number of

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cob plant^{-1} followed by A_1 seedlings (12 day old) with no significant difference. The maximum cob length of 29.69 cm with husk and 21.7 cm without husk was recorded by transplanting A_2 seedlings (22 day old), which showed a significant difference in comparison with transplanting A_1 seedlings (12 day old). The lowest cob length of 27.71 cm with husk and 19.57 cm without husk was noted with transplanting A_3 seedlings (32 day old). The maximum cob girth of 19.06 cm with husk and 15.62 cm without husk was recorded by transplanting A_2 seedlings (22 day old), followed by transplanting A_1 seedlings (12 day old). The lowest cob girth of 16.80 cm with husk and 12.63 cm without husk was obtained by transplanting A_3 seedlings (32 day old). The maximum cob weight of 373.53 g with husk and 287.03 g without husk was recorded by transplanting A_2 seedlings (22 day old), followed by transplanting A_1 seedlings (12 day old). The lowest cob weight of 345.92 g with husk and 244.23 without husk was obtained by transplanting A_3 seedlings (32 day old).

In regard to nutrient sources, the number of cobs per plant showed significant differences ranging from 1.23 to 1.44. Treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) registered a significantly higher number of cobs per plant, followed by treatment F_1 (RDF). The minimum number of cobs per plant was observed under treatment F_0 (no fertilizers). Similarly, for length, girth, and weight (with and without husk) of cob, treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) outperformed the rest of the treatments with the least values recorded under treatment F_0 (no application of fertilizers). The maximum value of cob weight with 421.80 g and without husk 308.61 g was recorded under the application of 50% RDF + poultry manure@2 t ha^{-1} and followed by RDF. The lowest cob weight with husk of 244.94 g and without husk of 206.11 was obtained under control. Treatment F_3 (1/2 RDF + 4 t ha^{-1} vermicompost) and treatment F_2 (1/2 RDF +12 t ha^{-1} FYM) were at par with respect to length, girth, and weight (with and without husk) of the cob.

Yield and the Harvest Index. The economic yield of a plant is determined by its yield attributes. Data revealed that by transplanting A_2 seedlings (22 days old), a maximum green cob yield of 138.35 q ha^{-1} was obtained, followed by A_1 seedlings (12 days old) with a green cob yield of 133.07 q ha^{-1} (Table 7 and Figure 4). The lowest green cob yield of 120.50 q ha^{-1} was obtained from transplanting 32-day-old seedlings. A similar trend was observed in the green fodder yield, with a maximum yield of 193.63 q ha^{-1} obtained under transplanting A_2 seedlings (22 day old). The lowest green fodder yield of 170 q ha^{-1} was obtained from transplanting 32-day-old seedlings.

A significant reduction in the crop yield with no application of fertilizer in treatment F_0 was observed. Plots applied with treatment F_2 (1/2 RDF + 12 t ha^{-1} FYM) were found at par with F_3 (1/2 RDF + 4 t ha^{-1} vermicompost) for the green cob and green fodder yield (Figure 5). Treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) produced statistically superior results than other treatments and registered a green cob yield of 119.23 q ha^{-1} without husk and a green fodder yield of 227.67 q ha^{-1} followed by RDF. The lowest green cob yield of 68.07 q ha^{-1} without husk and a green fodder yield of 141.44 q ha^{-1} were observed under control. Furthermore, transplanting A_2 seedlings (22-day-old seedlings) recorded the significantly highest value for the harvest index (41.91), which was associated with the efficient assimilate partitioning between the source and sink (Table 7 and Figure 4). Likewise, treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) registered the significantly highest value of the harvest (43.27), which was followed by treatment F_1 (RDF), as shown in Figure 5.

Table 7. Yield of Sweet Corn Influenced by Seedling Age and Nutrient Sources[a]

treatments	green cob yield (q ha^{-1}) with husk	green cob yield (q ha^{-1}) without husk	green fodder yield (q ha^{-1})	harvest index
Age of Seedling (days)				
A_1: 12	133.07	99.74	177.83	40.19
A_2: 22	138.35	105.68	193.63	41.91
A_3: 32	120.50	84.96	170.00	38.51
SE(m)±	1.76	1.43	4.96	0.64
CD ($p \leq 0.05$)	5.09	4.13	14.38	1.58
Sources of Nutrients				
F_0: Control	79.84	68.07	141.44	35.30
F_1: RDF	149.35	107.36	197.00	41.72
F_2: 1/2 RDF + 12 t ha^{-1} FYM	127.69	94.56	164.56	39.99
F_3: 50% RDF + 4 t ha^{-1} VC	132.57	96.42	171.78	40.73
F_4: 50% RDF + 2 t ha^{-1} PM	163.76	119.23	227.67	43.27
SE(m)±	2.27	1.84	6.41	0.83
CD ($p \leq 0.05$)	6.57	5.33	18.57	1.29

[a]CD = critical difference.

Relative Economics. An appreciable influence was observed on the relative economics of different treatments (Table 8). The data revealed that maximum net returns of ₹ 6,45,659 and the highest benefit−cost ratio (BCR) of 6.57 were registered with transplanting A_2 seedlings (22 day old) along with the use of treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure), followed by same seedling age receiving treatment F_1 (RDF) having a BCR of 6.32. The lowest values for net returns of ₹ 2,33,435 and a BCR of 2.76 were recorded with A_3 seedlings (32 day old) under treatment F_0 (no application of fertilizer). It is self-evident that higher productivity in terms of the green cob and green fodder yield realized with transplanting A_2 seedlings (22 day old) and treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure), accompanied by relatively lower cost of production, resulted in the superiority of the treatment in terms of the monetary value over the rest of the treatments. These findings are supported by refs 12 and 13.

■ DISCUSSION

The older seedlings are subjected to more transplanting shock due to a larger transpiring area than younger seedlings, which causes a reduced growth rate of older seedlings in comparison with younger seedlings. Transplanting of A_2 seedlings (22 day old) recorded a significantly maximum plant height up to the harvest than the rest of the seedlings. The rate of establishment of seedlings in the field is governed by the regenerative capacity of roots so as to resume their root activity. Thus, the performance of older seedlings is hampered due to an imbalance created between huge transpiration losses and the water uptake capacity of roots. These findings are supported by the results discussed in refs 12 and 14. There was a significant variation observed in both the number of functional leaves and the leaf area index due to seedling age. The decrease in the number of leaves with increasing seedling age was associated with the reason that older seedlings experienced a more transplanting shock. Thereby, the plants were unable to perform well in producing a greater number of leaves, which, in turn, reduced

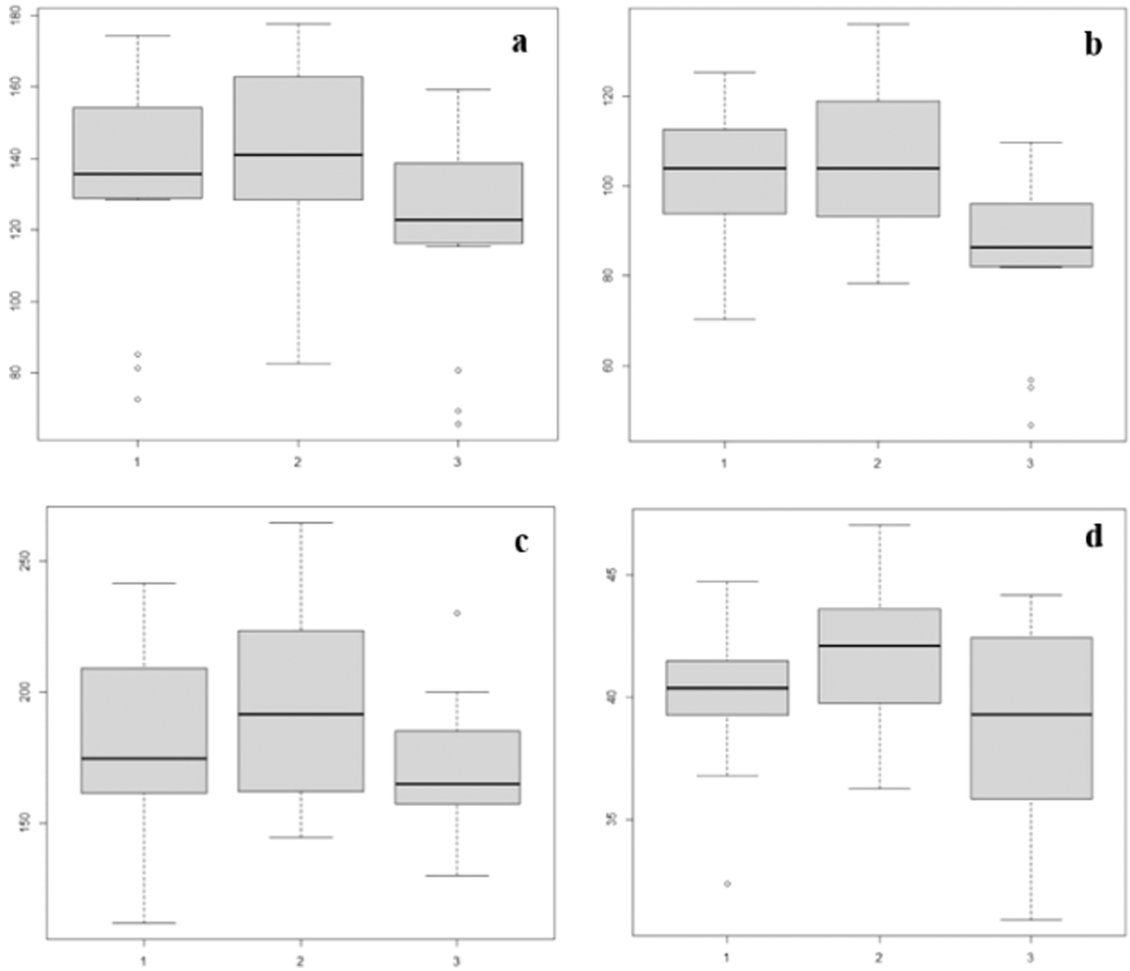

Figure 4. Boxplot showing variations in (a) green cob yield with husk, (b) green cob yield without husk, (c) green fodder yield, and (d) harvest index of three seedling ages (1: 12 day old; 2: 22 day old, and 3: 32 day old).

the leaf area index of older seedlings. Initially, 32-day-old seedlings recorded a maximum leaf area index of up to 30 DAT, but thereafter, 22-day-old seedlings recorded a significant maximum leaf area index. These results are in agreement with the results reported in ref 12. They found that transplanting younger seedlings recorded more leaf area index and root volume. Ref 15 also reported similar results. The marked difference in growth parameters under different sources of nutrients can be because of better utilization of nutrients during crop growth under phased release of nutrients. Chemical fertilizers are known to have the characteristic nature of releasing their nutrient contents at a faster rate, thus making them available to the plant at earlier stages of growth. In contrast to inorganic fertilizers, organic sources of plant nutrients release them slowly through mineralization. This slow release of nutrients into the rhizosphere ensures their availability throughout the crop growth period, leading to a significant impact on the growth characteristics. In comparison with other organic nutrient sources, the higher performance of poultry manure was attributed to higher nutrient content and comparatively faster release due to a narrow C/N ratio. This finds coherence with refs 16 and 17. The transplanting of older seedlings resulted in a significant decrease in yield attributes of sweet corn, *viz.*, cob length, cob girth, and cob weight. This may be because of the shortened growth period in older seedlings, implying earlier attainment of maturity. A shorter growth period leads to a reduction in the grain filling period and results in inadequate filling of grains, whereas young-aged seedlings accumulated more dry matter, which encouraged the yield attributes. However, the number of cobs per plant in different ages of seedlings showed no significant difference. These results are in agreement with refs 9 and 18. Furthermore, the economic yield of a plant is determined by its yield attributes; hence, the superiority of transplanting A_2 seedlings (22 day old) in terms of yield attributes resulted in superiority of yield in terms of the green cob and green fodder yield in the same seedlings. Application of F_4 (1/2 RDF + 4 t ha^{-1} poultry manure) increased the length, girth, and weight of the cob. A high assimilation rate due to efficient utilization of available resources enhanced growth performance in terms of the above-discussed growth parameters and led to the production of more dry matter, which, in turn, contributed to sufficient availability and proper partitioning of assimilates to sink, leading to a significant increase in yield attributes and yield. The findings are in consonance with refs 19−21.

■ CONCLUSIONS

This study indicated that seedlings of too lesser age are not able to express their potential to the fullest, and transplanting too aged seedlings also is not able to show enhanced performance due to the aforementioned reasons. Therefore, for high crop stand, growth, and productivity, transplanting sweet corn at

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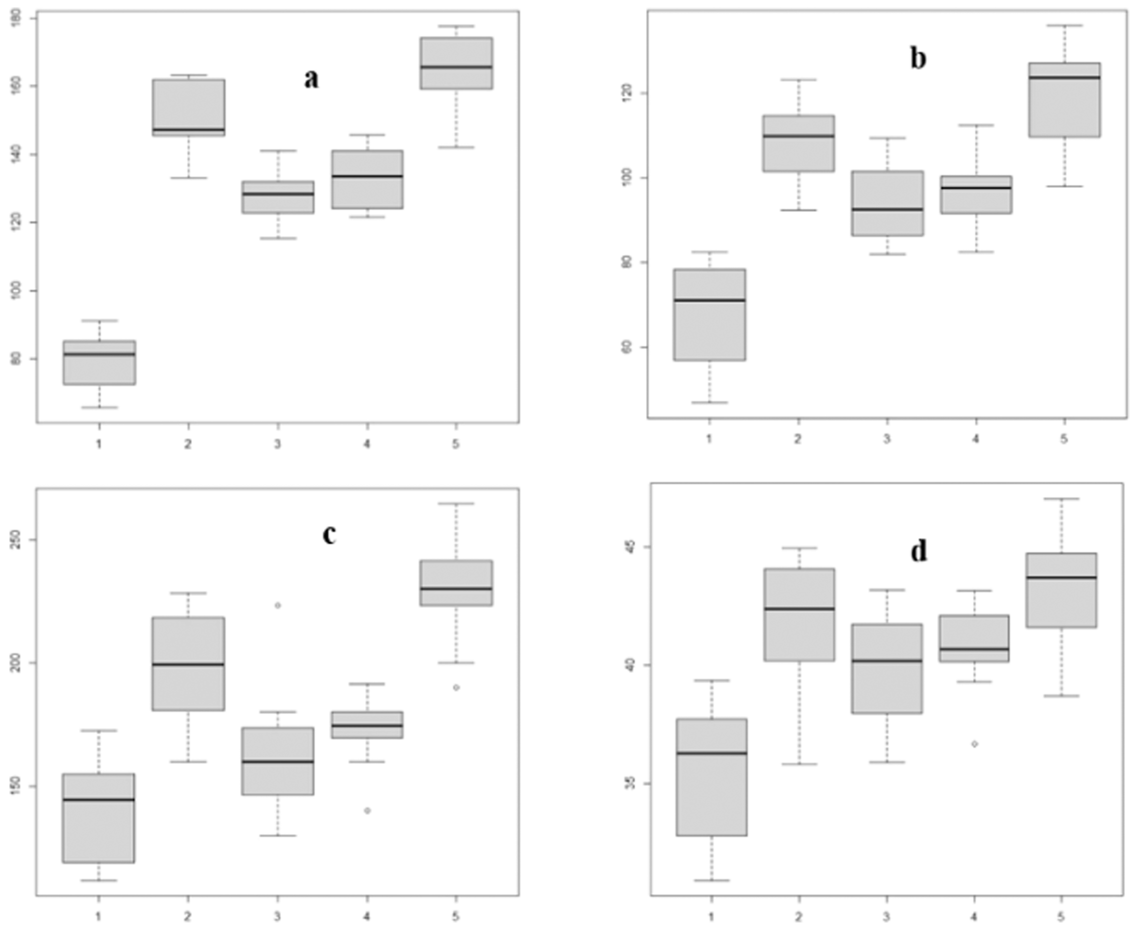

Figure 5. Boxplot showing variations in (a) green cob yield with husk, (b) green cob yield without husk, (c) green fodder yield, and (d) harvest index of five nutrient sources (1: control; 2: RDF; 3: 1/2 RDF + 12 t ha^{-1} FYM; 4: 1/2 RDF + 4 t ha^{-1} vermicompost; and 5: 1/2 RDF + 2 t ha^{-1} poultry manure).

Table 8. Gross Returns, Net Returns, and BCR of Sweet Corn Influenced by Seedling Age and Nutrient Sources

treatment combination	cost of cultivation (₹ ha^{-1})	gross returns (₹ ha^{-1})	net returns (₹ ha^{-1})	BCR
A_1F_0: 12-day-old seedling (control)	84 550	341 768	257 218	3.04
A_1F_1: 12-day-old seedling + RDF	91 968	648 713	556 745	6.05
A_1F_2: 12-day-old seedling + 1/2 RDF + 12 t ha^{-1} FYM	112 259	561 397	449 138	4.00
A_1F_3: 12-day-old seedling + 1/2 RDF + 4 t ha^{-1} VC	136 259	574 842	438 583	3.22
A_1F_4: 12-day-old seedling + 1/2 RDF + 2 t ha^{-1} PM	98 259	712 576	614 317	6.25
A_2F_0: 22-day-old seedling (control)	84 550	383 161	298 611	3.53
A_2F_1: 22-day-old seedling + RDF	91 968	672 880	580 912	6.32
A_2F_2: 22-day-old seedling + 1/2 RDF + 12 t ha^{-1} FYM	112 259	564 560	452 300	4.03
A_2F_3: 22-day-old seedling + 1/2 RDF + 4 t ha^{-1} VC	136 259	596 110	459 851	3.37
A_2F_4: 22-day-old seedling + 1/2 RDF + 2 t ha^{-1} PM	98 259	743 918	645 659	6.57
A_3F_0: 32-day-old seedling (control)	84 550	317 985	233 435	2.76
A_3F_1: 32-day-old seedling + RDF	91 968	588 850	496 883	5.40
A_3F_2: 32-day-old seedling + 1/2 RDF + 12 t ha^{-1} FYM	112 259	505 008	392 749	3.50
A_3F_3: 32-day-old seedling + 1/2 RDF + 4 t ha^{-1} VC	136 259	522 974	386 715	2.84
A_3F_4: 32-day-old seedling + 1/2 RDF + 2 t ha^{-1} PM	98 259	645 195	546 936	5.57

optimum seedling age is a prerequisite. In this study, transplanting A_2 seedlings (22 day old) showed significant results for growth and yield attributes and, ultimately, for yield of sweet corn. Similarly, plots applied with treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) performed statistically better than other treatments. Furthermore, it was reflected that transplanting A_2 seedlings (22 day old) and application of treatment F_4 (1/2 RDF + 2 t ha^{-1} poultry manure) resulted in realizing the highest returns and the maximum BCR. Hence, this practice can be recommended for profitable sweet corn production under temperate climatic conditions.

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