Standardization of Seedling Characteristics for Paddy Transplanter

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***Abstract*—TheseA field experiment was conducted duringkharif 2012 at ARS, Gangavathi, UAS, Raichur to standardize the suitable age of seedlings, stage and concentration of GA_3 spray for mechanical transplanting of rice seedlings. The treatment consisted of different age of seedlings (20, 25 and 30 days old seedlings) and two concentrations of GA_3 (25 and 50 ppm) and sprayed on 10 days and 15 days old seedlings. The results revealed that 30 days old seedlings along with spraying of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher seedling growth parameters like shoot length (26.62 cm), root length (12.29 cm), root volume (9.33 cm3) and lowest was recorded with 20 days old seedlings without GA_3 spray (14.2 cm, 6.26 cm and 4.00 cm3) respectively. Whereas, 20 days old seedlings with spraying of GA3 @ 50 ppm on 15 days old seedlings recorded higher number of tillers per hill (22.9), seed yield (47.05 q/ha), straw yield (23.7 q/ha), lowest unfilled seeds (6.1) and highest B:C ratio (2.7). Among the various age of seedlings and concentration of GA_3 used for the study, twenty days old seedlings along with spraying of GA_3 @ 50 ppm on 15 days old seedlings were found most suitable for walk behind mechanical transplanter in order to get better seedling establishment, plant growth, seed yield and to realise more profit by minimising the cost of seed production.**

***Index Terms*—paddy transplanter, seedling, characteristics, seedling growth, GA_3**

I. Introduction

Rice (*Oryza sativa* L.) is the major staple food for more than half of the global population and considered as the "global grain". About 90 per cent of rice grown in the world is produced and consumed only in Asian countries and it supplies 50 to 80 per cent calories of energy to Asians. Rice is grown under wide range of latitudes and altitudes and is the anchors of food security in the world with challenges of climate change [1]. Total estimated area under rice production in the world is 159 million hectares with a production of 670 million metric tonnes and the average yield is 3889 kg per hectare [2]. India ranks second in the production of rice; as it is grown in almost all the states in India. Total estimated area under rice in India is 44.40 million hectares with a production of 104.32 million tones.

To meet the food demands of the growing population and to achieve food security in the country, the present production levels need to be increased by two million tonnes every year. It is estimated that 120 million tonnesof rice is required to feed the growing population by 2020. To get higher yields, transplanting of healthy and vigorous seedlings is pre-requisite which producesuniform stand with higher yield than direct seeded rice. Transplanting is done manually, which is tough and involves enormous drudgery and human stress in sweltering weather. It requires about 300-350 man hours per hectare, which is approximately 25 per cent of total labour requirement for paddy cultivation. Non availability of labour has compounded the situation and paddy transplanting has emerged as the problem in the major rice growing areas of this region. This results in delay in transplanting and decrease in yield. It is reported that a delay in transplanting by one month reduces the yield by 25 per cent and a delay of two months reduces the yield by 70 per cent. In spite of the huge labour requirement, plant to plant and row to row spacings are not achieved as the workers transplant seedlings at far wider spacing that too randomly than recommended and hence mechanical weeding is not possible. So also, the scarcity of labour at peak demand period results an increased cost of operation and delays the transplanting operation.

Therefore, it is high time for mechanizing the transplanting operation in rice seed production fields. Mechanical transplanting needs a suitable transplanter. Mechanical transplanter using self-propelled transplanter has been considered as the most promising option because it saves labour to the tune of 90 per cent of that required in manual transplanting, minimizes stress and drudgery, ensures timely transplanting and attains optimum plant density contributing to higher productivity. The use of paddy transplanter is popular in rice growing areas across the world and consistently evaluated for the quality of seedlings. The Japanese paddy transplanter can transplant about 0.65 hectare per 8 hours but the spacing between row to row was more than recommended one and the control of the machine in the puddled soil was difficult [3]. Parida and Das [4] developed a model and tested in laboratory based on number of plants per hill, percentage of missing hills, effect of seedling chamber and paddling index on the performance of the machine. In some of the transplanters, the man-hr requirement per ha in actual transplanting, the man-hr requirement for filling up the seedling tray reduces the advantage of the former system to a large extent [5]. Garg *et al.*[6] studied

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the four levels of seedling age, four levels of mat moisture and three levels of planting speed for two soil types and obtained that rice seedling up to 30 days old grown in any of two soils with moisture varying from 10 to 15 per cent could be used to reduce the mat consumption and number of seedlings per hill.

The use of transplanter is found to reduce the delay in transplanting and which contributed increase in yield [7]. To ensure uniformity in height of the seedlings, they can be treated with gibberellic acid @ 100 ppm for transplanting with a transplanter [8]. The mechanical transplanting can reduce cost of labour but the cost of raising nursery is more [9]. Sang-Su *et al*. [10] trans-planted three rice cultivars with 3 different seedling age to investigate their growth habits and observed that the 10 days old seedlings had more vigorous elongation of plant height and higher tillering ability but lower effective tiller rate, when compared with 35-day or 40-day old seedlings.

Behera and Varshney [11] studied correlation between puddling and mobility of the transplanter and found they are inversely proportional. Rotary and peg type puddlers may be used with one pass so as to minimize the sedimentation period for transplanting operation [12]. Tripathi *et al*. [13] revealed that transplanting of rice by usingself-propelled rice transplanter is one of the alternative methods for the manually random planting. The use of rice transplanter economized time, labour, cost of cultivation, better crop establishment and higher yield when compared with manual transplanting of rice. There can be the difference between two methods of transplanters on the basis of nursery used i.e. machine using wash root seedling and machine using mat type seedlings (mat type seedlings are raised on a polythene sheet with the help of frames) and observed that 20-30 days seedlings were found most suitable for transplanting [14]. Aswini*et al.*[15] evaluated three rice transplanters namely OVAT, CRRI and Yanji in sandy soil conditions with respect to number of seedlings per hill, missing hill, floating hill, mechanical damaged hills and hill mortality. They reported that 20 day old seedlings were most suitable for all the transplanters under study. Highest numbers of effective tillers per hill were produced with seedling of 10 days age [16].

Considering all these aspects, the present investigation was carried out with the following objectives;

- To standardize correct age of seedlings suitable for mechanical transplanter
- To find out the suitable stage and concentration of GA3 spray for better seedling growth
- To assess the seedling establishment, plant growth, seed yield and economics of mechanical transplanted seed crop

II. Materials and Methods

A. Selection of Variety

The seeds of GangavahtiSona (GGV-05-01) were used for the experiment. Seeds of this variety are thin and medium size with a test weight (1000 seeds) of 11 to 13 g. The seeds are considered to be of premium quality. The duration of the variety is 135 days.

B. Type of the Transplanter

Walk behind type paddy transplanter was used for transplanting the paddy Seedlings. The specs for the transplanter are as follows:

Nursery used	**Mat type**
Man power requirement	One (operator)
Operating width, mm	1200
Number of rows	4
Row to row spacing, cm	30
Plant to plant spacing, mm	100 to 210
Planting depth, mm	20-50
Type of fingers	Fixed opening type
Size of Seedling mat on the transplanter, mm	400 x 200 x 20
Weight of the machine without nursery mats, kg	200
Approximate cost of the Machine, Rs	2,00,000

C. Plot Size and Treatment Details

Gross Plot Size-14.0 X 5.0 m and Net Plot-13.0X4.0 m. The treatments imposed are

Main Plot (M)-Age of Seedlings for Transplanting: M1-20 Days old seedlings, M-2-25Days old seedlings and M3-30 Days old seedlings.

Sub plot (S): **Concentration of GA3 & Age of Seedlings**: S_1: control, S_2: Foliar spray of $GA_3$25ppm on 10 days old seedling, S_3: Foliar spray of GA_3 50 ppm on 10 days old seedling, S_4: Foliar spray of GA_3 25 ppm on 15 days old seedling, S_5: Foliar spray of GA_3 50 ppm on 15 days old seedling

D. Replication and Design

The treatments were imposed in three replication and split plot technique was used to analyse data collected from different as per procedure prescribed by Sundarrajan*et al*. (1972). Critical difference were calculated at five per cent level wherever 'F' test was significant.

E. Attributes Analysed

The data on attributes like seedling vigour index, seedling dry weight, plant height, no. of green leaves per plant, leaf area per plant, no. of tillers per sq. mt., Total dry matter produced, no. of panicles per sq. mt, panicle length, no. of seeds per panicle, test weight, sraw and harvest index were collected as per the standard procedures mentioned as follows:

1) Shoot length (cm)

Ten normal seedlings were randomly selected from each treatment and length of shoots was measured from collar region to the tip of top most leaf and expressed in centimetre.

2) Root length (cm)

The length of the roots was measured from collar region down to the tip of the longest root of each seedling and the average was expressed in centimetres.

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3) Root volume (cubic cm)

The root volume was calculated by displacement method. Five plants were uprooted at random from the net plot and the root portion of the five plants was cut and collected. The beaker was filled with 500 ml of water and then the entire root mass of fiveplants was dipped in water. The rise in the water level in the beaker was noted down and this gives the root volume and was expressed in cubic centimetre.

4) Seedling dry weight (mg):

The randomly selected seedlings for measuring seedling length obtained after final count were dried at 70 ± 1°C for 24 hours in hot air oven, and dry weight in milligrams was recorded by weighing them in an electronic balance.

5) Root weight (g)

The roots obtained from randomly selected seedlings used for observing seedling dry weight obtained after final count were dried at 70 ± 1°C for 24 hours in hot air oven and the dry weight of roots in milligrams was recorded by weighing them in an electronic balance.

6) Plant height (cm)

The plant height was measured from five randomly selected tagged plants from base of the plant to the base of fully opened top leaf and the average plant height was taken and expressed in cm.

7) Number of green leaves per plant

Total numbers of fully opened green leaves from five tagged plants were counted and mean per plant was computed.

8) Leaf area per plant

Leaf area per plant was worked out by following procedure given by Gomez and Gomez (1984). The length and maximum width of each leaf on the middle tiller was computed as follows;

Leaf area (cm^2) of each leaf = K × L × W in middle where,

K = adjustment factor

L = maximum length of leaf

W = maximum width of the leaf

At seedling stage and at harvest, K value of 0.67 was used and for all other stages, K value of 0.75 was used.

9) Number of tillers per Sq.m

Number of tillers per sq.m was counted at 30, 60, and 90 DAS and at harvest in each treatment at randomly selected area and expressed in tillers per sq.m.

10) Total dry matter production (g plant-1)

Five plants were uprooted randomly from the net plot at 30, 60 90 DAS and at harvest. The root portion of the plant was discarded. The above ground portion of plant samples were washed in water and dried under the sun, then kept in hot air oven at 65 ^{o}C for 24 hours for further drying. The mean dry weight plant^{-1} was calculated and expressed in grams.

11) Number of panicles per sq.m

Number of panicles persq.m was counted at harvest from each treatment at random and expressed in number of panicles per sq.m.

12) Panicle length

Length of panicle from five panicles selected at random in each lot was recorded from base to tip of panicles and the mean was computed and Expressed in centimetres.

13) Number of seeds per panicle

The total number of seeds obtained from ten panicles were threshed and separated into fully filled and chaffy seeds and mean was worked out and expressed as number of seeds per panicle. The per cent chaffy seed was calculated by using the following formula.

Chaffyness (%) = A ÷ B X 100

where, A - Number of unfilled seeds per panicle
B -Total number of seeds per panicle

14) Test weight

Thousand seeds were counted from ten randomly selected plants and weight was recorded in grams.

15) Seed yield

The crop in the net plot was harvested, threshed, dried in sun. The seeds were cleaned and weight was recorded and converted into hectare.

16) Straw yield

The straw from net plot after threshing was dried in sun, weighed and converted into hectare.

17) Harvest index

Harvest index was calculated by the formula as outlined by Donald andHumblin[17].

Harvest Index = A÷ (B+C)

where, A - Seed yield (kg ha^{-1})
B - Seed yield (kg ha^{-1})
C - Straw yield (kg ha^{-1})

III. Results and Discussion

The results of the study are given in Table I and the details as follows:

A. Effect of Age of Seedling on Seedling Growth Parameters

Higher shoot length and root length (24.28 cm and 10.70 cm) was recorded by 30 days old seedlings followed by 25 days old seedlings (20.73 cm and 10.27 cm) and the lowest shoot length was recorded by 20 days old seedlings (18.91 cm and 8.39 cm).Thirty days old seedlings recorded higher root volume of paddy (7.07 cm^3), followed by 25 days old seedlings (0.16 g and 6.60 cm^3). Whereas, lower root volume of paddy was recorded with 20 days old seedlings (5.73 cm^3). 30 days old seedlings recorded higher seedling dry weight of paddy (0.12 g), followed by 25 days old seedlings (0.08 g) and lowest was recorded with 20 days old seedlings (0.07 g).

This might be due to better photosynthetic activity of aged seedlings resulting in more translocation of photosynthates to the roots and shoots which enhanced their elongation. The results are in confirmation with earlier findings of Alam *et al*. [18] and Ginigaddara *et al*. [19].

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TABLE I. EFFECT OF AGE OF SEEDLINGS AND GROWTH REGULATOR ON GROWTH AND YIELD PARAMETERS IN PADDY

Treatments	Shoot Length -cm	Root Length -cm	Root Volume -cm^3	Seedling Dry Weight -g	Plant Height -cm	Leaf Area- cm^2	No of Tillers per hill	Days to 50 % flower	Panicle Length -cm	Filled Seed per Panic	1000 Seed Wt.-gm	Seed Yield- kg / ha
Main Plot-M												
M1-20 Days old Seedling	18.91	8.39	5.73	0.07	68.27	20.62	20.9	118.67	22.1	120.6	21.45	41.40
M2-25 Days old Seedling	20.73	10.27	6.60	0.08	68.35	19.64	20.2	114.53	22.7	123.3	22.74	40.00
M1-30 Days old Seedling	24.28	10.70	7.07	0.12	65.64	19.62	18.4	109.80	21.5	118.2	22.14	38.69
S.Em±	0.10	0.06	0.10	0.001	.69	0.19	0.8	0.18	0.2	3.4	0.16	0.65
CD @ 5%	0.21	0.17	0.30	0.01	NS	NS	2.4	0.52	NS	NS	NS	2.0
Sub Plot-S												
S1-Control	16.78	7.66	4.22	0.06	63.47	17.40	17.90	112.78	21.8	121.1	21.8	34.70
S2-GA_3 25 ppm-10 DOS	22.32	8.92	5.33	0.09	67.40	19.30	18.30	113.67	22.0	124.8	22.0	39.25
S3- GA_3 50 ppm-15 DOS	22.92	10.69	6.33	0.10	68.67	19.93	20.00	114.33	22.4	124.4	22.4	42.65
S4- GA_3 25 ppm-10 DOS	23.98	10.80	7.00	0.10	68.47	20.64	20.70	115.11	22.2	125.6	22.2	43.10
S5- GA_3 50 ppm-15 DOS	24.14	10.85	8.11	0.11	69.09	22.19	21.70	115.78	22.2	128.3	22.2	44.15
S.Em±	0.13	0.13	0.12	0.001	0.89	0.25	1.0	0.24	0.2	4.44	0.21	1.7
CD @ 5%	0.36	0.36	0.34	0.01	2.52	0.70	3.1	0.64	NS	NS	NS	4.8
Interaction												
M1S1	14.20	6.26	4.00	0.09	63.00	18.00	17.20	116.70	21.50	102.83	17.47	34.15
M1S2	18.00	7.03	4.67	0.12	67.40	19.70	17.10	117.30	22.80	115.63	19.63	38.55
M1S3	19.43	8.82	6.33	0.11	67.73	20.70	18.00	119.00	22.80	140.92	21.07	40.80
M1S4	21.04	9.76	6.33	0.13	67.67	21.40	20.30	121.00	20.90	146.67	20.33	42.45
M1S5	21.88	10.08	7.33	0.13	65.40	23.40	22.90	113.30	22.70	169.50	19.67	47.05
M2S1	13.55	8.79	3.67	0.05	63.27	17.90	18.80	114.00	22.50	89.95	18.67	32.95
M2S2	21.67	9.93	5.33	0.07	67.20	19.10	19.10	114.30	23.00	111.25	19.33	38.95
M2S3	21.95	10.19	6.00	0.10	70.87	19.50	20.50	114.30	22.80	120.27	21.73	42.05
M2S4	22.35	11.12	6.33	0.09	67.80	20.50	20.20	115.30	23.90	129.42	21.47	43.25
M2S5	24.13	11.31	7.67	0.10	72.20	21.50	22.00	115.70	21.50	148.30	19.67	45.66
M3S1	22.61	7.92	5.00	0.05	64.13	17.30	17.60	108.30	21.30	84.43	18.00	36.95
M3S2	23.79	9.81	6.00	0.07	67.60	19.20	18.70	109.70	20.40	98.58	19.37	40.20
M3S3	24.16	11.21	6.67	0.08	70.40	19.50	21.40	109.70	21.50	115.95	20.50	41.90
M3S4	24.24	12.28	8.33	0.08	69.93	20.30	21.50	110.70	21.60	123.75	19.27	41.90
M3S5	26.62	12.29	9.33	0.09	69.67	21.70	20.20	110.70	22.40	137.92	21.33	44.05
S.Em±	0.22	0.14	0.21	0.002	1.54	0.43	1.7	0.41	0.4	7.68	0.36	3.00
CD @ 5%	0.62	0.38	0.58	NS	NS	NS	5.2	NS	NS	21.30	1.01	9.00

Legend: M_1S_1 - 20 Days old seedling + Control; M_1S_2 20 Days old seedling + GA_3 25 ppm+10 DOS; M_1S_3 - 20 Days old seedling + GA_3 50 ppm+10DOS; M_1S_4 - 20 Days old seedling + GA_3 25 ppm on 15 DOS; M_1S_5 - 20 Days old seedling + GA_3 50 ppm on 15 DOS; M_2S_1 - 25 Days old seedling + Control; M_2S_2 - 25 Days old seedling + GA_3 25 ppm+10 DOS; M_2S_3 - 25 Days old seedling + GA_3 50 ppm+10DOS; M_2S_4 - 25 Days old seedling + GA_3 25 ppm on 15 DOS; M_2S_5 - 25 Days old seedling + GA_3 50 ppm on 15 DOS; M_3S_1 - 30 Days old seedling + Control; M_3S_2 - 30 Days old seedling + GA_3 25 ppm+10 DOS; M_3S_3 - 30 Days old seedling + GA_3 50 ppm+10DOS; M_3S_4 - 30 Days old seedling + GA_3 25 ppm on 15 DOS; M_3S_5 - 30 Days old seedling + GA_3 50 ppm on 15 DOS;

B. Effect of Age of Seedling on Crop Growth Parameters

Twenty days old seedlings recorded maximum number of tillers per hill (20.9) whereas, 30 days old seedlings recorded minimum tillers per hill (18.4). This may be due to profuse tillering during vegetative growth and then decrease gradually and lowest number of panicle bearing tillers was found due to non-effective side tiller mortality. The transplantation of young seedling (20 days old) results in quick recovery, better establishment and production of more tillers. The results are in agreement with the findings of Alam *et al*. [18] Partha and Haque [16] and Tadesse *et al*. [20].

Twenty days old seedlings recorded higher days to 50 per cent flowering (118.67) of paddy followed by 25 days old seedlings (114.53). The lower number of days to 50 per cent flowering of paddy was recorded with 30 days old seedlings (109.80). Aged seedlings required more days to panicle initiation due to the slow establishment of the seedlings in the main field unlike the younger seedlings. The findings are in conformity with the results of Alam *et al*. [18] and Krishna and Biradar [21].

C. Effect of Age of Seedling on Yield Parameters

Twenty days old seedlings recorded maximum seed yield (41.4 q/ha) and 30 days old seedlings which recorded minimum seed yield (38.69 q/ha). This may be due to profuse root growth in the case of 20 days seedling which helps in better tillering. More tillering provides

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better photosynthesis to support root and shoot growth which ultimately contribute to greater seed filling and bolder seeds. This also provides sufficient nutrient for vegetative growth. Similar results were reported by Alam *et al*. [18], Amin and Haque [22] and Partha and Haque [16].

Twenty days old seedlings recorded the higher straw yield of paddy (22.11 q/ha) while, lower straw yield of paddy was recorded with 30 days old seedlings (20.30 q/ha). Transplanting of younger seedlings through transplanter avoid root damage which is very much essential for better anchorage of the seedlings and better absorption of nutrients and result higher number of bearing tillers per hill and less mortality rate of side tillers was noticed in 20 days old seedling. The results are in conformation with the findings of Alam *et al*. [18] Faruk *et al*. [23]. Twenty days old seedlings recorded higher harvest index (0.676) and lowest harvest index was recorded in 30 days old seedlings (0.666). Similar observations were reported by Reza *et al*. [24].

D. Effect of GA_3 on Seedling Growth Parameters

Spraying of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher shoot length and root length (24.17 cm and 10.85 cm) whereas, lowest shoot length was recorded with control (16.78 cm and 7.66 cm).Spray of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher root volume of paddy (8.11 cm^3) while, lower root weight and root volume was recorded in control (0.09 g and 4.22 cm^3). Spray of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher seedling dry weight (0.11 g) of paddy while, lower seedling dry weight was recorded with control (0.07 g). This may be due to increased hypocotyl extension and to a lesser extent, to extension of the first internode. GA_3 is a potent growth regulator known to increase cell division and cell elongation and hence better root and shoot growth was observed, which naturally synthesize more food (photosynthetic) and translocation towards the root, might have resulted in increase in diameter. The results are in accordance with findings of Kaushal, [25] and Gul *et al*. [26].

E. Effect of GA_3 on Crop Growth Parameters

Spray of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher plant height of paddy (69.09 cm), while lower plant height was recorded with control (63.47 cm).Spray of GA_3 @ 50 ppm on 15 days old seedlings recorded maximum number of tillers per hill (21.7) followed by spray of GA_3 @ 25 ppm on 15 days old seedlings (20.7) and the minimum number oftillers per hill was recorded in control (17.9).This indicated that foliar application of gibberellic acid increased cell size, stem height, stem thickness, internode length of the seedlings. Cell elongation is primarily responsible for the increase in internode length. The results are in confirmation with the findings of Kim *et al*. [8], Wahyuni *et al*. [27] and Kaushal [25].

Spraying of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly more number of days to 50 per cent flowering (115.78), followed by applying of GA_3 @ 25 ppm on 15 days old seedlings (115.11). Significantly lower number of days to 50 per cent flowering was recorded in control (112.78). This might be due to more active growth of expanding leaves and length of spike stalk and increased transfer of photosyhnthates form source to sink. Similar results were reported by Khuankaew *et al.* [28].

F. Effect of GA_3 on Yield Parameter

Spray of GA_3 @ 50 ppm on 15 days old seedlings recorded maximum seed yield (44.15 q/ha) whereas, control treatment recorded minimum yield (34.70 q/ha). This may be due to profuse vegetative growth and better yield parameters such as plant height, number of tillers, number of productive tiller per hill, number of filled panicles and 1000 seed weight. The results are in accordance with results of Azizi *et al*. [29].

Spraying of GA3 @ 50 ppm on 15 days old seedlings recorded significantly higher straw yield (22.39 q/ha) while, lower straw yield was recorded in control (19.11 q/ha). This may be due to an increase in the number of lateral branches perplant, photosynthesis and consequently the amount of dry matter. Similar results were reported by Azizi *et al*. (2011). Spray of GA_3 @ 50 ppm on 15 days old seedlings shown higher harvest index (0.678) whereas, the lowest harvest index was noticed in control (0.664).

G. Effect of Interaction on Age of Seedling with Spray of GA_3 on Seedling Growth Parameters

Thirty days old seedlings along with spray of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher shoot length and root length (26.62 cm and 12.29 cm) while, lower shoot length was recorded with 20 days old seedlings which did not receive GA_3 spray (14.2 cm and 6.26 cm).

Thirty days old seedlings along with spray of GA_3 @ 50 ppm on 15 days old seedlings recorded significantly higher root volume of paddy (9.33 cm^3), followed by 30 days old seedlings along with spray of GA_3 @ 25 ppm on 15 days old seedlings (0.2 g and 8.33 cm^3) while, root volume was recorded with 20 days old seedlings in control (4.00 cm^3).

H. Effect of Interaction on Age of Seedling with Spray of GA_3 on Crop Growth Parameters

Twenty days old seedlings along with spray of GA_3 @ 50 ppm on 15 days old seedlings recorded higher number of tillers per hill (22.9). Whereas, 20 days old seedlings without spray of GA_3 recorded lower number of tillers per hill (17.1).

I. Effect of Interaction on Age of Seedling with Spray of GA_3 on Yield Parameters

Twenty days old seedlings along with spray of GA_3 @

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50 ppm on 15 days old seedlings recorded maximum seed yield (47.05 q/ha) the minimum seed yield was recorded in 25 days old seedlings without spray of GA_3 (and 32.95 q/ha).Twenty days old seedlings with spray of GA_3 @ 50 ppm on 15 days old seedlings recorded higher 1000 seed weight (21.73 g) and the lowest was recorded with 30 days old seedlings without spray of GA_3.

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