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Seed yield of radish as affected by uprooting time and root cutting

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ABSTRACT

The experiment was conducted at the Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during November 2005 to April 2006 to study the seed production potentiality of BSMRAU developed open pollinated radish varieties (viz., BU Mula 1 and BU Mula 2) under two levels of root cutting (viz., one third and no cutup) and three levels of uprooting namely 30, 40 and 50 days after sowing (DAS). Results revealed that both root cutting and uprooting days significantly influenced most of the characters pertaining to seed yield per plant. Root cutting delayed the flowering, pod initiation, maturation of siliqua and reduced plant height, number of branches per plant, number of siliqua per plant, and number of seeds per siliqua. The yields were also impaired by root cutting. In general, the entire yield components and seed yield were highly affected with the one third root cutting. Various uprooting days also had influenced these characters. In case of treatment combination of no cut and 30 days of uprooting there was a significant difference between the varieties. The variety BU Mula 2 produced better seed yield per plot than BU Mula 1. Also in both the varieties the 1/3rd cut treatment with 30 or 50 days uprooting sequence showed unsatisfied number of seeds per siliqua in comparison to the no cut treatment except 40 days uprooting.

INTRODUCTION

Radish (*Raphanus sativus* L.) is one of the most important winter vegetable crops grown in both tropical and temperate region. It is highly cross-pollinated crop belonging to the Cruciferae family. It is a very popular and cheap winter vegetable in Bangladesh. Radish is grown for its young tender tuberous root, which are eaten in raw state as salad or by cooking as vegetable. Next to potato and brinjal, radish is the third major vegetable crop in Bangladesh in terms of both area and production (Regan 2013). In Bangladesh radish is an area 171 ha producing 202 thousands metric tons of fleshy edible roots (BBS 2008). Total annual vegetable production in Bangladesh is 4467 thousand metric tons of which radish produce 201 thousand metric tons (Anon. 2005). Both the fleshy roots and tender leaves are good source of vitamin-C containing 15-40 mg per l00g of edible portion and its leaves are good source of protein (Srinivas and Naik 1990). Tender leaf is also a good source of minerals (Sadhu 1986). Available elements in radish include aluminum, barium, lithium, manganese, silicon, titanium, fluorine and iodine (up to 18µg/100g). Its preparation is useful for liver and gallbladder troubles (Ahmed 1999). In Bangladesh, the production of radish was 200980 metric tons from 22364.37 ha. of land during 2000-2001 yielding about 8.99 metric tons/ha. and required about 201 metric tons of seeds is required (Anon. 2001). On the other hand, in the year of 2002- 2003 area used for radish production was 22698 ha. with a production of 198520 metric tons. In the year of 2003-2004 area used was 23348 ha. with the production of 210895 metric tons which seems to be similar production trend but development and use of new varieties can increase the yield potential of radish compared to the production of traditional varieties (Tyagi 1998). The wider adaptability, short duration, good taste and less crop failure indicates that there is enough scope to improve the

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crop and extend area and production. Most of the improved hybrid varieties grown in the country are of temperate types which usually do not produce seeds under Bangladesh condition. Chinese origin open pollinated varieties of radish usually produce enough seeds under the growing condition of Bangladesh.

The climate of Bangladesh is suitable for producing seeds of annual type radish varieties and farmers of some areas of Bangladesh use locally produced seeds, but the yield of locally produced seeds are not satisfactory. Locally produced radish seeds can hardly meet 50% of the requirement (Islam and Haque 1979). Although, radish is one of the most widely grown winter vegetables in Bangladesh, the present yield of radish is far below the levels attainable in the developed countries of the world. The use of outdated, susceptible, low productive obsolete type varieties is the main cause for low yield (Shahidullah et al. 1991). BU Mula 1 and BU Mula 2 are two open pollinated radish varieties which is utilizing segregating populations of Japanese hybrid radish variety. The varieties are of temperate type having seed production potentiality under Bangladesh condition. Seed production potentiality of these varieties in comparison to locally available exotic and local varieties is low. Enhancement of seed production potentiality is essential for mass expansion of the above two improved radish varieties in the country.

There are some reports that the seed yield of radish can be increased by uprooting the plants before flowering and again transplanting after cutting off a part of root (Nath and Kalvi 1970). Ahmed (1976) suggested that radish plants should be uprooted just before flowering and the roots and shoots should be cut leaving two inches of roots and one inch of shoot before transplanting for better seed production. Shinohara (1984) reported that the root to seed method of seed production is common in Kanto district of Japan with the Nerima group of radish varieties, where after 40-45 days of sowing the roots were uprooted and selected considering different external characters and then the shoots were cut at a half of the length in order to avoid withering of roots before transplanting. Katyal and Chadha (1985) suggested that radish roots should be uprooted at the marketable stage and then the selected roots should be transplanted for seed production. He also reported that cutting of about 1/2 to 2/3rd of the root and trimming off the top leaves without injuring. Findings are available for seed production by root cutting of popular varieties in Bangladesh. But such information is not available for two released varieties, viz., BU Mula 1 and BU Mula 2 variety. Considering the above facts, the study was undertaken to study the effects of different levels of root cut and root cuts at different days after seed sowing on yield of radish seed.

MATERIALS AND METHODS

The experiment was conducted at the research field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during November 2005 to April 2006. Two open pollinated varieties, viz., BU Mula 1 and BU Mula 2 were included in the study. The soil was silt loam in texture having acidic (pH=5.5) in nature, poor fertility status and impeded internal drainage.

The three-factor (variety, cutting, uprooting) experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. The unit plot size was 10 square meter.

Good quality radish seeds were sown in lines on 23rd November, 2005 maintaining a spacing of 60 cm between rows. Each plot contained four rows and each row contained 12 to 15 plants before thinning. Finally, eight plants were allowed in each row after thinning.

Well decomposed cow dung was applied to the plots at the rate of 10 t/ha. Urea (375kg), Triple super phosphate (TSP, 225kg) and Muriate of potash (MP, 225kg) were applied for supplying N, P_2O_5 and K_2O, respectively. Borax was also used at the rate of 2.0 kg/ha for supplying boron. Half of urea and MP and total amount of TSP were applied in the plots during final land preparation; the remaining half of urea and MP were top-dressed in two equal splits at 3rd and 5th weeks after sowing of seeds (Anon. 1983). Borax was applied before flowering. Radish plants at the age of 30, 40 and 50 days were uprooted carefully. Uprooting was done early in the morning. Then the plants were given different root cuts as per treatment combinations (one third cut and no cut of roots) of the experiment immediately after uprooting. After cutting, they were planted again in the same plot maintaining same plant to plant distance (30 cm) and row to row spacing (60 cm). Irrigation was applied immediately after planting. Data were recorded from ten randomly selected plants from each plots on days to 50% flowering in plants, days to full blooming, days to pod initiation, days to 80% maturity, plant height, number of siliqua per plan, branches per plant, number of seeds per siliqua, seed yield per plant, seed yield per plot/ha. Data were analyzed using MSTAT-C software and the means were compared according to Duncan's Multiple Range Test (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Seed yield and its component characters

The results related to the effect of different levels of root cuttings and uprooting on seed yield

and quality in two radish varieties BU Mula 1 and BU Mula 2 are presented and discussed in this chapter under the following heads.

Days to 50% flowering

The 1/3rd cut and no cut of roots at various days of uprooting significantly influenced the 50% flowering in the BU Mula 1 and BU Mula 2 (Table 1). In BU Mula 1, when the roots were cut one-third and not cut, it was found that 50% flowering occurred at 55 days in the treatment combination of no cut and uprooting after 40 days. In BU Mula 2, when the roots were not cut and uprooted after 40 days, 50% flowering was observed at 54.67 days. Irrespective of variety, no cut treatment and uprooting at 40 days showed the earliest 50% flowering. In both the varieties, the 1/3rd cut treatment with different uprooting sequence showed delayed 50% flowering in comparison to the no cut treatment. It was, however, evident that no root cut combined with uprooting in 40 days induced earlier flowering. The effect of treatment combination of 1/3rd cut with 30 days uprooting and 1/3rd cut with 50 days uprooting both for BU Mula 1 and BU Mula 2 were statistically similar. The effect of treatment combination for BU Mula 1, 1/3rd cut with 40 days uprooting, no cut with 30 days and 50 days uprooting and for BU Mula 2, 1/3rd cut with 40 days uprooting, no cut with 30 and 50 days uprooting were found statistically similar. The above results indicate that root cutting or uprooting of radish might have a significant relationship with response to flowering.

Days to full blooming

The l/3rd cut and no cut at various days of uprooting significantly influenced the days of full blooming in the BU Mula 1 and BU Mula 2 (Table 1). In BU Mula 1 when the roots were treated by 1/3rd cut and no cut, it was found that, days to full blooming occurred at 57.00 days in the treatment combination of no cut and 40 days uprooting.

In BU Mula 2, when the roots were not cut and uprooted at 40 days, full blooming was observed at 56.67 days. Irrespective of the variety, the no cut treatment and uprooting at 40 days showed the earliest full blooming. In both the varieties, the 1/3rd cut treatment with different uprooting sequence showed delayed full blooming in comparison to the no cut treatment. It was, however, evident that no root cut combined with uprooting in 40 days induced earlier full blooming. The effect of treatment combinations of 1/3rd cut and 30 days uprooting, 1/3rd cut and 50 days uprooting for BU Mula 1, 1/3rd cut and 30 days uprooting, 1/3rd cut and 50 days uprooting for BU Mula 2 were statistically similar.

The effect of treatment combination of 1/3rd cut with 40 days uprooting, no cut with 30 days and 50 days uprooting both for BU Mula 1 and BU Mula 2 were found statistically similar.

Days to pod initiation

Days to pod initiation was significantly influenced by cutting and cut at various days of uprooting (Table 1). The longest period (83.00 days) from sowing to pod initiation was taken by the plants having l/3rd cutting with 50 days uprooting. In BU Mula 1, when the roots was treated by no cut with 40 days uprooting, it was observed that pod initiation started on 74 days after sowing, the treatment receiving no root cut with 40 days uprooting for BU Mula 2 resulted the earliest (73.67 days) pod initiation. Pod initiation was delayed with early and late uprooting days. The treatment combination of l/3rd cutting with 30 days and 50 days uprooting, the no cutting with same days uprooting, were statistically dissimilar. Other treatment combinations showed statistically similar effect.

Table 1. Effect of variety, root cut and uprooting on the number of days to 50% flowering, full blooming, pod initiation and 80% maturity in radish

Variety	Cutting	Uprooting (days)	Days to Fist flowering (50% of plant)	Days to full blooming	Days to pod initiation	Days to 80% maturity
BU Mula 1	One-third	30	64.33 a	67.33 a	81.33 ab	122.00 ab
		40	59.67 b	61.33 b	78.33 c	119.67 b
		50	64.33 a	67.67 a	82.00 ab	122.67 b
	No cut	30	58.67 b	61.67 b	80.00 bc	124.00 a
		40	55.00 c	57.00 c	74.00 d	113.67 b
		50	59.00 b	62.33 b	78.00 c	120.33 b
BU Mula 2	One-third	30	63.33 a	66.67 a	82.33 ab	122.67 b
		40	59.67 b	63.00 b	78.33 c	119.67 b
		50	64.67 a	67.67 a	83.00 a	122.67 ab
	No cut	30	58.67 b	62.00 b	79.67 bc	120.00 b
		40	54.67 c	56.67 c	73.67 d	114.00 b
		50	59.33 b	63.00 b	80.67 abc	118.00 b
$LSD_{(0.05)}$			**2.07**	**2.90**	**2.56**	**20.32**
CV%			**2.04**	**2.73**	**1.91**	**9.83**

Table 2. Effect of root cut and uprooting on the plant height and number of siliqua per plant in radish

Variety	Cutting	Uprooting (days)	Plant height (cm)	No. of siliqua per plant
BU Mula 1	One-third	30	120.33 ab	303.37 c
		40	125.47 a	418.00 a
		50	106.10 d	301.30 c
	No cut	30	124.67 a	342.57 bc
		40	133.51 a	445.70 a
		50	112.87 c	301.27 c
BU Mula 2	One-third	30	117.77 be	302.50 c
		40	123.53 ab	416.13a
		50	104.50 d	302.30 c
	No cut	30	123.17 ab	341.73 bc
		40	132.90 a	444.00 a
		50	113.43 c	360.43 b
LSD(0.05)			**6.23**	**37.66**
CV%			**3.10**	**6.24**

Days to 80% siliqua maturity

The difference among the root cutting and various days of uprooting treatments in the period required for the days of 80% maturity in both the BU Mula 1 and BU Mula 2 were found significant (Table 1).

In BU Mula 1 when the root was treated by 1/3rd cut and no cut, it was found that, 80% maturity occurred at 113.67 days in the treatment combination of no cut and 40 days uprooting, which was the lowest. On the other hand, BU Mula 2 took 114 days with same treatments. In both varieties, 1/3rd cut treatment and different uprooting sequence showed delayed full blooming in comparison to the no cut treatment. Best result was found for the no cut and uprooting at 40 days in BU Mula 1, no cutting with 30 days uprooting in BU Mula 1. All the combination treatments showed statistically similar effect.

Plant height

The difference among the root cut treatment on plant height was highly significant (Table 2). Similarly, uprooting days also influenced the height of plant. Plant height declined with the levels of root cut and uprooting days. No root cut showed maximum plant height. In case of 1/3rd root cut at various days of uprooting produced plant with minimum height than that of no cut treatment. In BU Mula 1, the tallest plant (133.51 cm) was observed in no root cutting with 40 days uprooting treatment. In the same variety, when the roots were cut 1/3rd with 50 days uprooting, the received plant hight was the lowest (106.10 cm). In BU Mula 2, l/3rd root cut with 50 days uprooting produced the shortest plant (104.50 cm). But with no cut and 40 days uprooting treatment, the plant height was 132.90 cm. Cutting of the storage food and thus reduction of storage food was possibly responsible for decreased plant height. In addition, root cutting increased the susceptibility of the attack of rot causing pathogens (Hartmann et al. 1981). The effects of treatment combination in 1/3rd cutting with 50 days uprooting was statistically different from other treatment combination.

The effects of treatment combination of 1/3rd cutting and 30 days uprooting, in BU Mula 1 and 1/3rd cutting and 40 days uprooting, no cutting and 30 days in BU Mula 2 were statistically similar,

The effects of treatment combination of 1/3rd cutting with 40 days uprooting, no cutting with 30 and 40 days uprooting BU Mula 1 and no cutting with 40 days in BU Mula 2 were statistically similar.

Kumar et al., (2007) observed that steckling of 1/3rd of the root size took the longest time to 50% flowering and 100% flowering. He also found that the earliness in flowering in full root and 2/3^{rds} of root size treatments can be attributed to rapid vegetative growth which in turn can be ascribed to unabated supply of nutrients stored on the stecklings till the adventitious root formation took place. The results were in keeping with an early report made from Punjab plains by Gill and Gill (1996). The plant height of different varieties negatively co-related with the different days of uprooting (Fig. 1). The plant height significantly reduced with the increase of uprooting after 40 days.

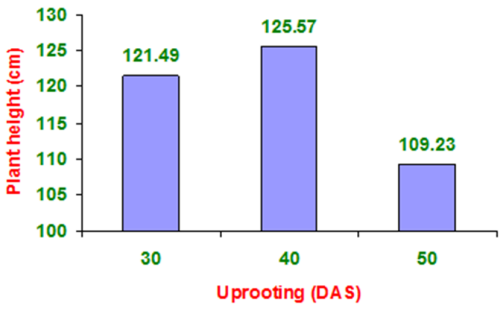

Fig. 1. Relationship between plant height and uprooting days

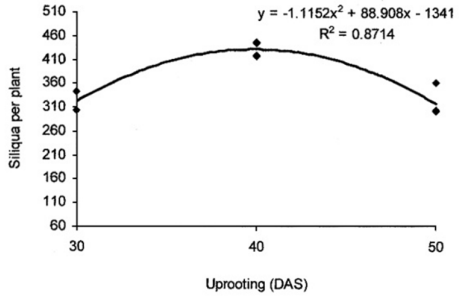

Fig. 2. Relationship between siliqua per plant and uprooting time

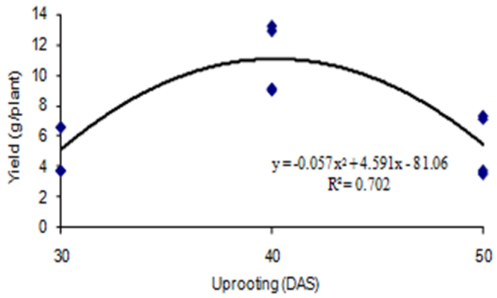

Fig. 3. Relationship between uprooting date and yield per plant

Number of siliqua per plant

The difference among the cutting and uprooting treatments in the number of siliqua per plant was highly significant (Table 2). Highest number (445.70) of siliqua per plant was obtained from the treatment combination of no cutting with 40 days uprooting in BU Mula 1. In BU Mula 2, the number of siliqua per plant was found to be 444.00 with similar treatment combination. Those treatment combinations were statistically similar. When the roots treated with no cutting and 50 days uprooting, it found to produce the minimum number (301.27) of siliqua per plant. The treatment combination of no root cut with 40 days uprooting resulted the tallest plants with increased number of branches, which ultimately produced more siliqua per plant. Uddin et al. (1985) showed a positive significant correlation between height and number of pods per plant in *Brassica sp.* which supports the present results. The siliqua per plant of different varieties were negatively correlated with the different days of uprooting (Fig. 2). The siliqua per plant was significantly reduced with the increase of uprooting days after 40 days. Reduction of siliqua per plant due to the change of uprooting days can be explained up to 87%.

Branch per plant

The cutting and uprooting treatments showed wide difference in the production of branches per plant (Table 3). The difference in the production of branches per plant among different cutting and uprooting treatments was statistically insignificant. The intact roots (no root cut) and uprooting at 40 days produced maximum number of branches (13.47) per plant followed by uprooting at 50 and 30 days in both the varieties. This reduction was increased gradually in treatment combination of $l/3^{rd}$ cut and other days of uprooting. One-third cutting and uprooting at 50 days produced minimum number of branches (5.00) per plant. The increased number of branches per plant in the no root cut treatment was associated with higher plant height (Uddin et al. 1985). The effect of treatment combination of no cut and 40 days uprooting in BU Mula 1 and no cut and 40 days uprooting in BU Mula 2 were statistically similar.

Number of seeds per siliqua

The effect of root cutting and days to uprooting on the number of seeds per siliqua was highly significant (Table 3). The maximum number of seeds per siliqua (6.47) was produced by the

Table 3. Effect of root cut and uprooting on the number of branches per plant, number of seeds per siliqua in radish

Variety	Cutting	Uprooting (days)	Branch per plant	Number of seed per Siliqua
BU Mula 1	One-third	30	5.23 e	3.40 c
		40	7.87 b	5.13 b
		50	5.00 e	2.60 cd
	No cut	30	6.07 d	2.93 cd
		40	13.47 a	6.47 a
		50	7.60 bc	2.33d
BU Mula 2	One-third	30	5.17e	2,67 cd
		40	7.33 be	4.67 b
		50	5.07 c	2.60 cd
	No cut	30	6.93 c	2.73 cd
		40	12.87 a	6.40 a
		50	7.73 b	2.67 cd
$LSD_{(005)}$			**0.68**	**0.79**
CV%			**5.40**	**12.66**

Table 4. Effect of root cut and uprooting on the seed yield per plant and seed yield per plot in radish

Variety	Cutting	Uprooting (days)	Seed yield (g/plant)	Seed yield (g/plot)
BU Mula 1	One-third	30	3.78 d	66.27 d
		40	9.08 b	160.30 b
		50	3.76 d	63.31 d
	No cut	30	6.54 c	116.71 c
		40	12.89 a	195.0 a
		50	7.32 c	117.33 c
BU Mula 2	One-third	30	3.76 d	66.66 d
		40	8.97 b	149.76 b
		50	3.54 d	63.18 d
	No cut	30	6.63 c	117.54 c
		40	13.20 a	210.0 a
		50	7.17 c	121.31 c
$LSD_{(0.05)}$			**1.07**	**12.01**
CV%			**8.78**	**5.58**

treatment with no root cut and 40 days uprooting. No root cut and 50 days uprooting produced the minimum number of seed per siliqua (2.33). The stickling receiving the treatment of no root cut was found to attain increased vegetative growth, which might have contributed towards increased number of seeds per siliqua. In both the varieties the 1/3rd cut treatment with different uprooting sequence showed unsatisfied number of seeds per siliqua in comparison to the no cut treatment except 40 days uprooting.

The treatment combination no cut with 40 days uprooting in both BU Mula 1 and BU Mula 2 were statistically similar. Other treatment combination showed statistically dissimilar effect.

The number of seeds per siliqua of different varieties was negatively correlated with the different days of uprooting (Fig. 3). The numbers of seeds per siliqua were significantly reduced with the increase of uprooting days after 40 days.

Seed yield per plant (g)

The yield of seed per plant was significantly influenced by root cutting and various days of uprooting (Table 4). The treatment with no root cut produced significantly higher yield of seed which decreased gradually with the extent of 1/3rd root cut. However, there was no significant difference among the treatment receiving no root cutting with 40 days uprooting in both the varieties. Those treatment combinations were different from the treatment combination of 1/3rd cut with various days of uprooting treatment.

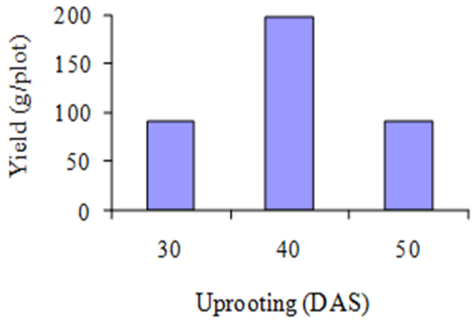

Fig.4. Relationship between uprooting date and seed yield per plant

The seed yield per plant was the highest (13.20g) in the treatment combination of no root cut with 40 days uprooting while the seed yield was the lowest (3.54g) in the treatment combination of 1/3rd cutting with 50 days uprooting. In BU Mula 2, the treatment combination of no cut and 40 days uprooting produced the highest yield (210 g/plot) in comparison of BU Mula 1 with same treatment combinations.

The yield of seed per plant of different varieties was negatively correlated with the different days of uprooting (Fig. 4). The yield of seed per plant was significantly reduced with the increase of uprooting days after 40 days.

Seed yield per plot (g)

The results of the statistical analysis on seed yield per plot were found to be similar to those of per plant yield (Table 4). The best treatment combination of no root cut with 40 days uprooting yielded 210.0g seed per plot. The results indicated that seed yield had a positive relationship with the number of branches per plant, number of siliqua per plant, and number of seeds per siliqua. These results agreed with the findings of Uddin et al. (1985) and Alam and Islam (1985). The yield of seed per plot of different varieties was negatively correlated with the different days of uprooting (Fig. 4). The yield of seed per plot was significantly reduced with the increase of uprooting days after 40 days.

CONCLUSION

The variety, root cut and uprooting were considered as the three factors of the experiment, was laid out in the randomized complete block design (RCBD) with three replications. Each of the three factors comprised two levels of root cut, two levels of variety and three levels of uprooting days giving a total of 12 treatment combinations. The effects of root cutting and uprooting in case of both variety of BU Mula were highly significanct in all the characters. It was evident from the results that the combination of no root cutting with 30 days uprooting produced flowers earler than any of the other treatment combinations. The treatment receiving no root cut produced the tallest plants with maximum number of branches. Plant height and number of branches per plant decreased with the 1/3rd root cut. The hight of plant was also affected by root cut. The number of siliqua per plant, number of seeds per siliqua and 1000 seed weight were significantly influenced by root cut with 40 days uprooting was found as the best in all these aspects. The yield of seed was significantly influenced by root cutting and uprooting. Types of root cutting at different growth stages exhibited significant influence for expression of all the characters in both BU Mula 1 and BU Mula 2. The treatment receiving no root cut with 40 days uprooting produced flower earlier, tallest plants with maximum number of branches, the number of siliqua per plant, and number of seeds per siliqua, yield of seed were significantly influenced. The best treatment combination of no root cut with 40 days uprooting yielded (210.0 g) seed per plot and 13.20g seed yield per plant. The treatment receiving one third cut with 50 days uprooting show poor performance for all the characters. The combination of no root cut with 40 days uprooting was found as the best in all these aspects.

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