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Seedling Performance, Growth and Yield of Onion Sown by Direct Seeding in Tropical Riparian Soil

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ABSTRACT

The objective of this study was to obtain a seed-origin onion (*Allium cepa* L.) that was able to grow in the tropical riparian soil. Research designed with non-experimental. Two cultivars were studied, namely Sanren and Lokananta. Onion seeds were planted directly without transplanting, there were three plots (4 m x 1.6 m x 0.3 m) and three germination testplot (1 m x 1.6 m x 0.3 m). Soil tillage, spacing/ population, fertilization, plant maintenance and pest-diseases control in accordance with the recommendations. Research result obtained Sanren had higher germination (94.40%) and vigor index (60.60) then Lokananta. The growth of two onion cultivars showed good performance because there was no transplanting. Almost all the the variables for seedlings, vegetative organs and bulbs were significantly different between two cultivars. From the boxplot test, it was found that the data were of symmetry for Sanren (number stems, dry weight of leaves, and dry weight of bulb), and the Lokananta cultivar (vigor index, number of stems, number of bulbs, plant height and leaf dry weight). There was a significant correlation for Sanren (plant height with bulbs weight and number of roots), and Lokananta cultivars (number of roots with number of stems and leaf dry weight). Fresh bulbs weight per clump from Sanren (46.71 g) and Lokananta (17.84 g).

INTRODUCTION

The technology package to improve onion production includes high quality cultivars, bulb quality, and extensification (Haile, Tesfaye, & Worku, 2017). Planting materials using seed of True Shallot Seed (TSS) exhibited more advatages compared to bulb such as seed handling much easier, free from pest, budged saving, and improved-production (Askari-Khorasgani & Pessarakli, 2019). Bulbs should be avoided in shallot reproduction as seeds show potential (Fairuzia, Sobir, Maharijaya, Ochiai, & Yamada, 2022). Saidah, Muchtar, Wahyuni, Padang, & Rahardjo (2020), underlined some of onion cultivars seeds ere available in the market viz., Tuk Tuk, Bima, Maja, Trisula, Gardeningrat, Purie Garden, and Maserapi. Lokananta and Sanren are onion hybrid seeds that are also available to purchase. Sanren is recommended for lowlandand its potential yield ranges between 19-28 t/ha, and Lokananta is widely adaptive from low land to upper land and its potensial production a little bit higher at 20-25 t/ha (East-West Seed Indonesia, 2017). Reproduction using bulbs has been widely practised on irrigation and rain fed fields. Cultivationon field using bulbs of Pusa Red and treated with vermi compost produced 23 t/ha (Andishmand & Noori, 2021). Reproduction by seeds had been reported from different countries as Russia by Matveeva, Zvolinsky, Yu Petrov, & Zaitsev (2021). Iran used TSS from Texas early,white, Texas earlyGrano and Sapidan (Daraby, 2020), Japan issued technology packages of onion cultivation using TSS (Askari-Khorasgani & Pessarakli, 2019). In Kenya

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production onion from seeds yielded 23.6 t/ha (Gateri, Nyankanga, Ambuko, & Muriuki, 2018).

The extensification of food crop in Indonesia is more directed to sub-optimal land such as Riparian wetlands. Riparian wetlands in South Sumatra has been used extensively for paddy fields. Some area has been intensified from 100 harvest index (once crop a year) to 200 harvest index a year and even few has reached 300 harvest index when the lands was irrigated andfully mechanized. Seeding cultivation of onion as the second crop in riparian wetland are becominga challange because of high onion consumption in South Sumatra. Lakitan, Hadi, Herlinda, Siaga, Widuri, Kartika, & Meihana (2018) reminded that some set backs may arise in horticultural cultivation in wet land of riparian ecosystem such as high acidity, low nutrients, and some other biological factors. Intensive technology package for riparian agriculture including experiments has been fully disseminated to the farmers and led the farmers to improve yield, crop rotation and harvest index. Karim & Ibrahim (2013) even recommended onion cultivation on acid soil (pH < 5.5 was pretreated with agricultural lime. Different biomass accumulation resulted from onion grown in hydrophonic between acidic media (pH 5.8) and normal (pH 6.5), resulted that K, Ca, Na,and Zn absorption was not significantly different. Roy, Saiful Islam, & Tabassum (2016) informed that onion cultivar could produce well in acid soil by addition of fertilizers. Onion TSS from Trisula cultivar is widely favored by farmers in Indonesia (Rosliani, Hidayat, Sulastrini, & Hilman, 2016). Tsagaye, Ali, Wegayehu, Gebretensay, Futa, & Fikre (2021) concluded that numberof bulb abd bulb weight were depended on growingenvironment. The research was aimed to evaluate cultivars Sanren and Lokananta grown from direct seeding and optimize techlonogy package for onionin area of riparian ecosystem.

MATERIALS AND METHODS

Research was carried out during dry season from July to October 2021 on the riparian paddy field of Pemulutan Ulu village, Ogan Ilir, South Sumatera, Indonesia. The GPS coordinate was S: 473246.27 and E: -343948.43. The position of each plot of Sanren and Lokananta cultivars was parallel from north to south, and each plot was separated with the distance of 1 m.

Two cultivars used in the research were Sanren and Lokananta. Both are hybrid cultivars, Sanren was intended for lowland, while Lokananta was adaptive to wider range from low land to highland area. Land was prepared by hoeing and plowing to make the soil smooth and flat. The dose of fertilizer, manure, and lime applied in the field was adjusted to the acidity of the soil. Procedures and doses of pesticides were adjusted to the recommendations from East-West Seed Indonesia. There were two plots with different sizes for germination test at 1.6 m x 1.0 m and for complete cultivation the plot size was the plot size was 4.0 m x 1.6 m. Both plot were raised up to 0.3 m height. Each type of plots was replicated 3 times. Soil type was Latosol. At 3 weeks before planting, addition of 3.6 kg Dolomite per plot was added to neutralize the soil pH from 4.5. The planting plots were also mixed with chicken manure at rate 5.0 kg per plot, and applied two days before planting. Basic chemical fertilizers were placed in rows at spaced of 3 cm from planting rows at one week before planting. Fertilizers were consisted of ZA at rate of 10 g, SP 20 g and KCl 15 g for each row. Second application using NPK (16:16:16) at rate 10 g per row was given at 21 days after planting. The same fertilizer with the rated of 15 g per row was applied at 40 days after planting.

Seeds were planted in 2.0 cm depth and distance between rows was 30 cm, so there were five rows in each plot. Planting rate of each row was 12 g seeds. Granular insecticide was applied following seed planting at 10 g per plot. Germination plots were divided into four rows and 25 seeds were placed in each row with three plot as replications.

Data Collection and Analysis

Data for the germination research was collected at 12 days after sowing based on parameters as reported by Sumarno, Hiola, & Nur (2021). Data for cultivation research was carried out on 10 sample plants randomly selected from each plot. All parameters were measured after harvesting. The parameters included number of leaves, number of stems, number of roots, root length, leaf fresh weight, leaf dry weight, number of bulbs, and bulb dry weight. Data were then analyzed using Boxplot to evaluate data variance of the two cultivars Sanren and Lokananta. Comparable data of the the same parameters of the two cultivars were analyzed using T-test. Correlation analysis was also made to measure the relation between variables.

RESULTS AND DISCUSSION

The acidic soil environmental conditions that had been improved, especially soil pH and soil nutrients from the riparian paddy field could createa rhizosphere that support the germination of onion seeds. Data from the results of this study showed that the quality of commercial onion seeds from the two cultivars was classified as good germination and their vigor index met the technical requirements for cultivation. Good onion germination was able to create good vegetative organs (roots, leaves, and stems), and generative organs (bulbs). The appearance of Sanren and Lokananta growth showed a significant difference, in that Sanren was better than Lokananta. The difference in growth ability was thought to be due to the better adaptation of the Sanren cultivar to the riparian soil environment during the dry season.

Based on Boxplot analysis on seedling growth, vegetative growth and yield between the two onion cultivars Sanren and Lokananta cultivated by direct seeding on tropical riparian rice field demonstrated different data distribution. However, symmetrical distribution of the two cultivars occurred on different parameters except number of stems (Fig. 1). Symmetrical distribution data on Sanren included number of stems, leaf dry weight, and bulb dry weight. Lokanata revealed data which were distributed symmetrical on vigor index, number of stems, number of bulbs, plant height, and leaf dry weight. Similar distribution data of tested cultivars occurred on number of stems and leaf dry weight.

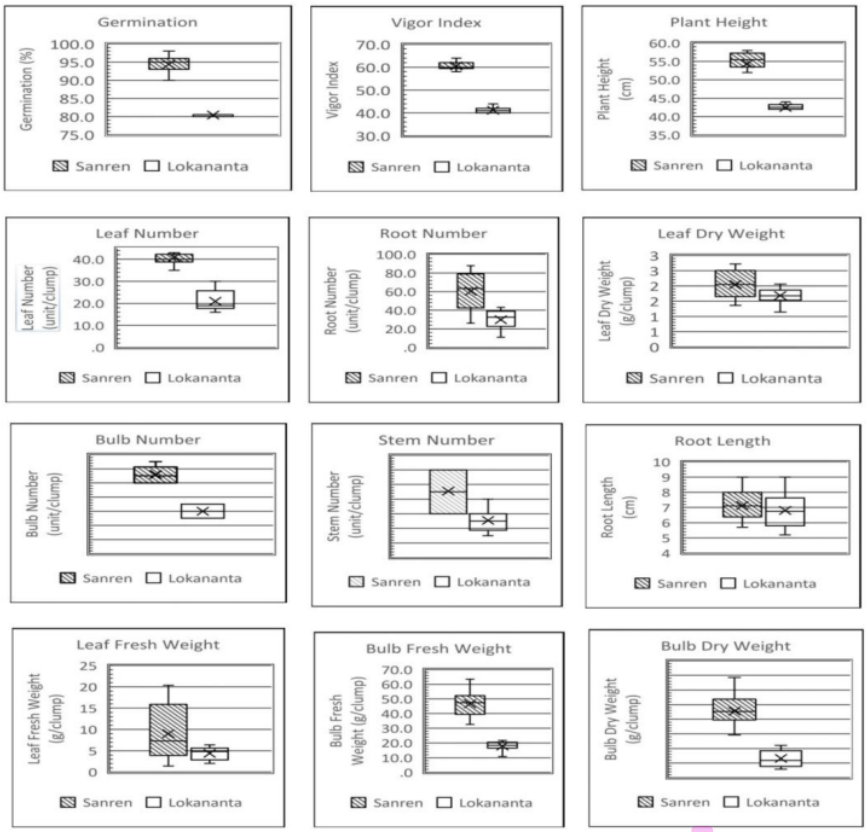

Fig. 1. Germination, growth and yield of Onion cultivars Sanren and Lokananta sown by direct seeding in riparian wetland

Population of Sanren, even though, exhibited high median value for the whole parameters, the high variations occurred in the symetric population were found in nine parameters. Variation exhibited by two cultivars were due to differences in seed quality, storage practices and storage period. Variation in germination among plots were also reported by Dianawati, Haryati, Yulyatin, Rosliani, & Liferdi (2021). Seeds have some qualities i.e. physic, physiology, genetics, and health. All the qualities were experiencing reduction with time after harvest. Physical quality of seed can be the primary access for other qualities to occur and may cause further damage and deterioration to the seed lot. Rate of seed deterioration was even faster if post harvest and storage practices were abruptly conducted. Prolonged storage period inevitably caused seed deterioration and, hence, lowering all other seed qualities.

Onion stem was a vegetative organ that developed from micro tubers, the interaction of genetic factors with the environment would determine the number of onion stems of a cultivar. This study found that the distribution of number of stems was normal for the two cultivars. This fact shows that the growing environment had arelatively less effect on stem formation. The numberof leaves from Sanren and Lokananta showeda normal distribution. The number of leaves can be a distinguishing feature of an onion cultivar in Indonesia (Fitriana & Susandarini, 2019). However, morphological characteristics such as number of leaves and number of stems were still not stable due to genetic and environmental influences.

Population variation was normal for root length for both Sanren and Lokananta, and was not significantly different between the two cultivars. The length of onion roots in the rhizosphere was affected by tillage, groundwater table and also the depth of the acid layer. The application of dolomite can spread until depth of less than 10 cm, and the lower layer was classified as acid soil. On acid soil, onion roots do not develop further so that the effect on root length is relatively the same. The root length of the two cultivars of onion is between 6 cm to 8 cm from the soil surface.

Performances of seedling, growth and yield of the two cultivars were significantly difference except on root length (Table 1). Germination percentages were above 70% and categorized good according to Agricultural Ministry Decree No. 131 (2015). Germination of Sanren (94.40%) even higher than that of Lokananta (80.40%). Planting beds were practically well prepared, and smooth to allowseeds resumed embryo growth, and undoubtedly toavoid water got stuck on the planting bed. Sanren was slightly adaptive to Latosol soil of riparian ecosystem and even resulted in higher physiological quality as it showed higher germination percentage. The differences were widening on vigor index as parameters and measurement were becoming more sensitive and accurate.

Table 1. Paramater performance of onion cultivars of Sanren and Lokanata cultivated by direct seeding on riparian wetland

No	Parameters	Standard Deviation		P (T<=t) two-tail
		Sanren	Lokananta	
1	Germination (%)	94.40 ± 2.50	80.40 ± 0.80	4.3E-12*
2	Vigor index	60.60 ± 1.80	41.20 ± 1.33	9.8E-16*
3	Plant height (cm)	54.4 ± 4.22	42.5 ± 1.12	1.81E-07*
4	Number of leaves (unit per clump)	40.90 ± 4.25	21.00 ± 4.63	1.95E-8*
5	Number of stems (unit per clump)	11.10 ± 2.62	6.10 ± 0.70	8.31E-4*
6	Number of bulbs (unit per clump)	11.20 ± 1.08	6.00 ± 0.77	6.99E-10*
7	Number of roots (unit per clump)	60.40 ± 10.52	29.80 ± 9.94	7.92E-4*
8	Root length (cm)	7.14 ± 0.96	6.81 ± 1.14	0.52
9	Leaf fresh weight (g per clump)	9.02 ± 6.31	4.37 ± 1.46	0.045*
10	Leaf dry weight (g per clump)	2.05 ± 0.46	1.68 ± 0.24	0.048*
11	Bulb fresh weight (g per clump)	46.71 ± 8.52	17.84 ± 3.14	1.84E-08*
12	Bulb dry weight (g per clump)	22.77 ± 7.01	6.60 ± 2.62	4.27E-06*

Harvest time was 2 days late but there was no difference between cultivars viz., 116-118 days after planting. The longer harvesting was subjected to allow leaves to dry out. Soil water table was higher at the end of growing season that resulted in lengthy greenish leaves. Data on leaf fresh weight and leaf dry weight were an indicator of how high water content embedded inside the leaf until at the end of the growing period before harvest. The genetic superiority of Sanren over Lokananta was also prevailed on stem height as underlined by Demisie & Tolessa (2018) and Roy, Saiful Islam, & Tabassum (2016). Kumar et al. (2015) added that distance between planting rows affected plant height, and plant growth for yield quality. Anda, Ginting, Sabaruddin, Hamimu, & Tufaila (2017) reported that soil water and fertility, geographical location have influenced on plant height. Plant height was also related to leaf size thus long leaves of Sanren was also accompanied by large leaf area. Number of stems and leaves of Sanren were significantly higher than those of Lokananta. Cultivar differences combined with lower population resulted in increasing number of leaves, leaf height, and produced bulbs. Spacious distance between planting rows, 30 cm wide, resulted in reduction in population, hence, allowed plants to grow larger and longer leaves and higher bulbs fresh weight. Similarly Jyoti, Navneet, Dhatt, & Gill, (2019) resumed the performance of varietal difference on specific ecosystem resulted in number of stem and leaves, and stem height of onion.

Superiority of Sanren over Lokananta was also revealed on number of roots, fresh and dry leaf weight, fresh and dry bulb weight. Root length, however, of the two cultivars were similar. Onion cultivars have different number and length of roots, as roots were influenced by soil fertility, and genotype. Fitriana & Susandarini (2019) also found variations on leaf length, number of leaves, and number of bulbs were found in 12 genotypes of onion in Indonesia. Root weight was accumulation of root length and number, and according to Sopha (2020) root weight was affected by plant population and NPK application. The reports regarding onion cultivation on riparian soil were still rare. Optimum tillage, followed by dolomite and chemical fertilizers application prior to planting were expected to improve rhizosphere. However, rhizosphere depth was slightly limited that prevented roots from elongated further down the soil. The higher number of roots of Sanren was useful for supplying nutrients and water for the shoot to support photosynthesis and shoot growth of Sanren. Furthermore, the growth of shoot would be useful for the formation of more stems and leaves from Sanren.

Leaf fresh and dry weight of Sanren were also higher than those of Lokananta. The results were also down-streaming effects descended from leaf number and plant height as ndicated earlier. Sanren exhibited higher plant height and leaf number over Lokananta consequently would have higher leaf weight, fresh and dry together. Leaf weight, fresh and dry, was depended on leaf number and affected by onion cultivars and growing substrate (Deshi, Obasi, Nanbol, Sirajo, & Okechalu, 2018). Rhizosphere as a growing medium was used by Sanren to extend the leaves, and increase the number of leaves so that the fresh weight and dry weight of the leaves was greater than Lokananta. It should also be mentioned that the appearance leaves of the two cultivars planted in riparian triggers the occurrence of long and small leaves. The condition of the leaves as a result of the direct planting system so that the seedling population was relatively more in the planting row. Excessive number of onion seedling would cause space competition among plants.

Onion bulbs played a role as the sink of photosynthetic accumulation distributed from leaves as sources. The rate of photosynthesis of onion depends on leaf stomata conductivity and temperature for short-day onion cultivars bulb at 10–11 hours of daylength (Bachie, Santiago, & McGiffen, 2019). Photosynthetic capacity of leaves would affect sink accumulation. Wijoyo, Sulistyaningsih, & Wibowo (2020) stated that onion bulb components was effected by quantity of its leaves. It was obvious that different cultivars was resulted in different bulb number and weight, even though, fertilizers and population were applied at the same rate (Wiguna, Hidayat, & Azmi, 2013). Cultivar diferences of onion according to Thingalmaniyan, Rohini, & Arumugam (2017) produced fresh and dry bulbs differently. Table 1 showed that the total dry weight of onion of Sanren were 24.28 g and Lokananta were 8.28 g. The distribution of dry weight accumulation to Sanren were leaves (9%) and bulbs (91%), and Lokananta were leaves (20%) and bulbs (80%). This fact indicates that the distribution of photosynthate of Sanren cultivars was greater than that of Lokananta. External factors that consisted of type and dose of fertilizers application, water availability in bedding plants also influenced fresh and dry weight of onion bulbs (Yahumri & Nurmegawati, 2015). Bulb production difference between Sanren and Lokananta was also in accordance to other vegetative growth findings

as mentioned earlier. Riparian soil setbacks as low pH, water unavailability, limited nutrients which might profoundly limited onion growth and yield, in fact, were counter attacking by good agronomic inputs given and imposed during planting bed preparation.

There was significant correlation between plant height, bulb weight, and number of roots of Sanren cultivar. Bulb weight depends on the size of the tuber and the number of bulbs, and the number of leaves in the onion clump. For onions of the Sanren cultivar, it turns out that the number of leaves was very significantly correlated with the weight of the bulbs. In Lokananta, significant correlation occurred between number of roots, number of stems, and leaf dry weight. Roots and stems support accumulation of photosynthate, thus Lokananta has higher leaves dry weight. There was also a correlation between the number of roots and the number of stems on leaf dry weight (Table 2).

Direct planting without transplanting on small seeds onion consumed more seeds and also resulted in high rate population and had no chance to arrange plant spaces (Devulkar, Bhanderi, More, & Jethava, 2015). When population rate was arranged with 30 cm space Sanren could use rhizospore which allow root to spread out and support growth by improvement of leaf number plant height. On the other hand, the plant height of the tall cultivars had a positive impact on the number of leaves and weight of bulbs. Correlation that occurred between number of roots and number of stems were revealed to all cultivars used in the research. Number of stems per clump determined number of leaves, followed by improvement in dry weight of onion leaves. Based on data from growth and yield, Lokananta was superior for plant height, number of leaves, leaf length, and bulbs yield. Gedam et al. (2022) shows that the genotype of onion is tolerant of waterlogging with adaptive properties of waterlogging stress.

Brar, Kaushik, & Dudi (2019) reported that percent germination was positively correlated with percent seedling establishment. Germination and vigor were not correlated on var. Sanren and var. Lokananta in the study. Germination and seed vigor index of onion were influenced by external factors and the biochemical conditions of the seeds. The internal factors of seeds are related to free radicals, and respiratory enzymes so that it strongly controls germination more than vigor in onions. Based on the correlation test, it was found that number and weight of bulbs of Sanren and Lokananta cultivars did not significantly correlate with germination, vigor index, plant height, number of stems, number of leaves, root length, number of roots, fresh weight of leaves, fresh weight of bulbs, and dry weight of bulbs (Table 2). The difference in the number of bulbs of the onion cultivars tested showed that the number of bulbs was controlling by a genetic factor. Differences in onion genotypes appear to be correlated with in leaf and bulbs morphology (Fitriana & Susandarini, 2019).

Fitriana & Susandarini (2019) and Gulumbe, Abubakar, Sokoto, & Aliero (2018) reported that the number of leaves and leaf length of onions correlated with bulbs. Number of leaves reflects the optimal growth of the onion. The number of leaves from Sanren was higher than Lokananta (Table 1). Based on the correlation test, it turned out that there was no correlation between the number of leaves on all variables for the two cultivars. This indicates that the number of leaves is not correlated with vegetative and generative organs. The results of this study are similar with the study of Chavda, Jethva, Zinzala, Sapovadiya, & Vachhani (2021) that the number of leaves has a direct effect on the yield of bulbs per plot. The weight of the bulbs in the onion plant was influenced by the size of the photosynthetic organs such as leaves. Data from the results of the study showed that the number of leaves and leaf length were not significantly correlated with bulb weight. The results of this study were different from those found by Gulumbe, Abubakar, Sokoto, & Aliero (2018) that leaf area and number of leaves were significantly correlated with bulbs weight. This fact indicates that leaf area is an important component in producing assimilate to be translocated to onion bulbs. The large number of leaves in the Sanren cultivar actually triggers the inhibition of leaf area. This condition was thought to be due to the close spacing of the plants. Therefore, the bulbs weight of Sanren from seeds from direct planting system (not transplanting) in rice fields of riparian was classified as not optimal compared to irrigated rice fields.

The adaptation of the Sanren cultivar was reflected in the plant height, number of stems, number of roots, number of bulbs, and bulbs weight which were better than Lokananta. The number of bulbs and bulb weight were important components of the economic yield of onion plants. The results of this study found that the number of bulbs on Sanren was 11 bulbs per clump and 6 bulbs per clump for Lokananta, and the weight were in Sanren bulbs 46.7 g per clump and 17.8 g per clump in Lokananta. The results obtained from this study indicate that the size of Sanren bulbs was larger than Lokananta.

Table 2. Correlation coefficient of growth and yield parameters of onion cultivars Sanren and Lokananta sown by direct seeding on riparian wetland

		A	B	C	D	E	F	G	H	I	J	K	L
A	sig F (L)	-											
	sif F (S)	-											
B	sig F (L)	0.68ns	-										
	sif F (S)	0.63ns	-										
C	sig F (L)	0.10ns	0.30ns	-									
	sif F (S)	0.36ns	0.16ns	-									
D	sig F (L)	0.62ns	0.65ns	0.03*	-								
	sif F (S)	0.12ns	0.8ns	0.53ns	-								
E	sig F (L)	0.70ns	0.11ns	0.2ns	0.10ns	-							
	sif F (S)	0.42ns	0.35ns	0.7ns	0.32ns	-							
F	sig F (L)	0.30ns	0.008ns	0.04*	0.14ns	0.09ns	-						
	sif F (S)	0.07ns	0.85ns	0.43ns	0.43ns	0.63ns	-						
G	sig F (L)	0.36ns	0.6ns	0.59ns	0.7ns	0.15ns	0.90ns	-					
	sif F (S)	0.45ns	0.18ns	0.27ns	0.22ns	0.80ns	0.21ns	-					
H	sig F (L)	0.59ns	0.42ns	0.42ns	0.09ns	0.07ns	0.36ns	0.39ns	-				
	sif F (S)	0.86ns	0.41ns	0.22ns	0.42ns	0.81ns	0.33ns	0.69ns	-				
I	sig F (L)	1.00ns	0.43ns	0.29ns	0.33ns	0.83ns	0.21ns	0.19ns	0.45ns	-			
	sif F (S)	0.71ns	0.05*	0.004*	0.72ns	0.65ns	0.23ns	0.23ns	0.26ns	-			
J	sig F (L)	0.10ns	0.94 ns	0.30ns	0.63ns	0.83ns	0.21ns	0.19ns	0.61ns	0.33ns	-		
	sif F (S)	0.36ns	0.01ns	0.16ns	0.34ns	0.72ns	0.32ns	0.39ns	0.70ns	0.48ns	-		
K	sig F (L)	0.12ns	0.63ns	0.88ns	0.51ns	0.59ns	0.38ns	0.51ns	0.37ns	0.52ns	0.44ns	-	
	sif F (S)	0.31ns	0.56ns	0.8ns	0.57ns	0.19ns	0.61ns	0.74ns	0.55ns	0.71ns	0.66ns	-	
L	sig F (L)	0.14ns	0.68ns	0.49ns	0.10ns	0.62ns	0.70ns	0.12ns	0.30ns	0.22ns	0.17ns	0.45ns	-
	sif F (S)	0.63ns	0.63ns	0.85ns	0.36ns	0.12ns	0.42ns	0.31ns	0.07ns	0.49ns	0.25ns	0.52ns	-

Remarks: (A) Number of bulbs, (B) Bulb dry weight, (C) Number of roots, (D) Number of stems, (E) Number of leaves, (F) Leaf dry weight, (G) Seed germination, (H) Vigor index, (I) Plant height, (J) Root length, (K) Leaf fresh weight, (L) Bulb fresh weight, (L) Lokananta and (S) Sanren

CONCLUSION

The Sanren cultivar had better germination (94%), morphology as indicated by number of leaves (40.90 unit per clump), and number and weight of bulbs compared to Lokananta cultivar. The direct seed planting from Sanren cultivar as technology package can be used in onion cultivation in riparian soil.

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