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Effects of Different Minituber Size and Planting Density on Yield and Yield Components of Basciftlik Beyazi Local Potato Cultivar

Yasin Bedrettin KARAN[a,1] (ybkaran@gmail.com)
Gungor Yilmaz[a] (gungor.yilmaz@gop.edu.tr)

[a]*Department of Crop Science, Faculty of Agriculture, Gaziosmanpasa University, 60240 Tokat*

Abstract – This study was conducted under net greenhouse conditions during 2013-2014 in Artova, Tokat, Turkey. The aim of this study was to determine the effect of different planting units on tubers yield of local cultivar Basciftlik Beyazi. Minitubers of Basciftlik Beyazi were produced at The Potato Research Institute, Nigde-Turkey. Three different sized minitubers (< 3 g, 3-7 g and > 7 g) were planted into pots as different planting units with three replications. Seven different planting units were created with planting of minitubers as single, double, triple or quadruple to each pot. Unit 1: one large size minituber per pot, Unit 2-4: Medium size tubers were planted as single, double and triple into each pots, respectively, Unit 5-7: Small size tubers were planted as double, triple and quadruple into pots, respectively. The experiments were arranged as Completely Randomized Block with three replications. The highest tuber number (49.68) per pot was obtained from was in Unit 6 in 2013 while the Unit 1 produced the highest number of tubers (42.84) in 2014. Mean comparison among number of tubers indicated that unit 6 and 7 had higher tuber numbers than other planting units. The highest tuber yields per pot (2160.0 g in 2013; 1921.04 g in 2014) were obtained from Unit 7 in both years. Also, in the second year of this study, results showed that the highest tuber yield per pot occurred in Unit 7 and Unit 1. As average of two years the highest tuber yield per pot (2040.52 g) were obtained from Unit 7. In conclusion, this study indicated that Unit 7 (four small size tubers per pot) is the best planting unit in terms of yield and yield components.

Keywords -
Potato, minituber, seed potato production.

[1]***Corresponding Author***

1. Introduction

Potato minitubers are the progeny tubers produced on *in vitro* derived plantlets [1]. Seed potato production involving minituber production systems has found its place all over the world. This system creates a bridge between the *in vitro* rapid multiplication and the field multiplication of seed tubers. This is a classical way to multiply or acclimatize *in vitro* material before its use in the open field. Producing minitubers from *in vitro* plantlets allows a faster rate of multiplication and reduces the number of field generations needed in seed production [2]. Minituber production improves the health status over conventional seed potatoes [3].

In spite of high sensitivity to abiotic stresses and other problems, *in vitro* generated potato plantlets are commonly used in seed potato production as a source of healthy propagation material. For the production of minitubers, they are generally planted in glass houses directly [4] or first raised under protected conditions and then transplanted into the field [5].

In the most of studies, minitubers have been produced successfully by taking out the plantlets from the culture vessel, washing the media, and planting the full plantlet in soil directly with or without weaning of root mass. Initial planting of micro-plants in furrow or on flat bed followed by mounding in both the methods gives similar plantlet establishment without any significant difference in the number and yield of minitubers/ m^2 [6].

The size of minitubers may range from 5-25 mm although in current systems larger minitubers have also become common. This size range coincides with a weight range of 0.1 -10 g or more [1]. The difference between microtubers and minitubers is not only in their size but also in the way they are produced. Microtubers are generated *in vitro* from micro-propagated plants, whereas, minitubers are generated by growing micro-propagated plants or microtubers *in vivo* under green or screen houses [7]. Some large sized microtubers may be of the same size or bigger than small minitubers.

Minitubers often have a diameter of 5–20mm and weigh 0.5–5 g. Provided that the initial plant material was free from diseases, these minitubers can be used as pre-basic seed. In many countries, healthy minitubers are the basis for seed multiplication programs, as this reduces the number of multiplications and hence the risk of contamination with diseases and pests in the field [8].

The aim of this research work was to determine the effect of different planting minitubers size and number on minitubers yield of Basciftlik Beyazi local genotype.

2. Material and Methods

The experiment was conducted during 2013 – 2014 under net greenhouse conditions in the Turkey-Tokat-Artova ($40{,}13^0$ N latitude and $36{,}33^0$ E longitude; 1193 m altitude). In this

experiment, virus free minitubers of Basciftlik Beyazi were produced meristem derived in vitro plants. The minitubers were produced in greenhouses by Potato Research Institute, Nigde-Turkey (PRI). Minitubers were graded into three size (small, medium and large) groups, and planted at different densities to create different planting units. Descriptions of each size group were given in Table 1, and details of planting units were presented in Table 2. The pots (40 cm in diameter, 36 cm deep and equivalent 28 lt) were filled with peat moss (Klasmann TS-1) as a production media. The experiments were arranged as Completely Randomized Block with three replications. Each replication was consisted of 10 pots. Minitubers were planted on 24th May, 2013 and 23rd May, 2014 and harvested by hand at the end of October in both years.

Table 1. Attributes of different size mini tubers as planting materials

Seed Type	Seed Size g	Seed Diameter cm	Seed-Eyes Number
Large Group	> 7 g	0.96	3.33
Medium Group	3-7 g	0.62	2.73
Small Group	< 3 g	0.43	1.62

Table 2. Explanation of different planting units

Unit 1	One large minituber per pot	Unit 5	Two small minitubers per pot
Unit 2	One medium minituber per pot	Unit 6	Three small minitubers per pot
Unit 3	Two medium minitubers per pot	Unit 7	Four small minitubers per pot
Unit 4	Three medium minitubers per pot		

The plants were irrigated as required to maintain adequate moisture levels by drip irrigation. The pots were fertilized 15:15:15 (N:P:K) at the time of planting in both years. Fungicide (Trooper 72 WP Formulation; 64% mancozeb + 8% metalaxyl-250g/100L) application was applied twice in both years. The No insecticide application was needed during the growing period in both years. Total number, average tuber weight, and tuber yield of the minitubers per pot were determined after harvest. An analysis of variance (ANOVA) was performed separately for each year and two-year mean in a Completely Block Design. The means were compared using a Duncan test, whenever the *F*-tests for treatments were significant at $p < 0.05$ [9].

3. Results and Discussion

The results in Table 3 showed that plant height and main-stem numbers of different planting units. According Table 3, the highest plant height belonged to the Unit 1. Besides, the highest main-stem number was obtained from Unit 7.

Table 3. Average plant height and main–stem numbers of different planting units

	Average Plant Height (cm)	Average Main-Stem Number
Unit 1	125.83	3.67
Unit 2	117.80	2.80
Unit 3	124.00	4.20
Unit 4	105.00	3.20
Unit 5	101.00	2.10
Unit 6	115.00	3.80
Unit 7	110.00	4.40

The results in Table 4 showed that the effect of different planting units on number of tuber per pot was in potato Basciftlik Beyazi local genotype significant at the 5 percent level in both years. The highest tuber number produced from Unit 6 (49.68) in 2013. In the 2014, the highest tuber number consisted of Unit 1 (42.84). Mean comparison among number of tuber indicated that unit 6 and 7 consisted of higher tuber number than other planting units.

It was reported that each plantlet produced about 2-5 minitubers in the farm and nursery but each plantlets in the greenhouse produced about 3-8 minitubers. The number and weight of produced minitubers depended on the production techniques [10].

Table 4. Effects of different minituber size and plant material number on potato tuber number yield and yield components

Planting Units	Number Of Tuber		
	2013	2014	Average
Unit 1	27.73 c**	42.84 a**	35.29 ab**
Unit 2	32.76 bc	25.82 b	29.29 b
Unit 3	36.01 abc	31.05 b	33.53 ab
Unit 4	42.44 abc	22.44 b	32.44 ab
Unit 5	37.33 abc	28.24 b	32.78 ab
Unit 6	49.68 a	27.62 b	38.65 a
Unit 7	45.80 ab	33.50 ab	39.65 a
LSD	14.23	10.74	7.67
% CV	20.59	14.25	18.71

**: Significant at 5 % level of probability ns : non-significant

The effect of planting units on average tuber weight was determined non-significant in the first year of experiment. However, in 2014, average tuber weight was detected significant ($P<0.05$). The highest tubers average weight (53.03 g) produced from Unit 1 in 2013. In the 2014, the highest average tuber weight consisted of respectively Unit 4, 2, 6, and 3.

Table 5. Effects of different minituber size and plant material number on average tuber weight (g)

Planting Units	Average Tuber Weight (g)		
	2013	2014	Average
Unit 1	53.03 ns	43.10 b	48.07 ns
Unit 2	53.65	62.94 a	58.30
Unit 3	44.50	56.39 a	50.44
Unit 4	46.63	66.74 a	56.69
Unit 5	38.80	46.74 b	42.77
Unit 6	40.83	60.02 a	50.43
Unit 7	47.30	57.57a	52.43
LSD	16.10	10.24	8.89
% CV	19.14	10.27	14.49

**: Significant at 5 % level of probability ns : non-significant

Results of planting units showed that differences among different minituber sizes and planting material number were significant ($P<0.05$) for the mean of tuber yield per pot. The highest tuber yield per pot produced from Unit 7 (2160.0 g; 1921.04 g) in both years. Also, second year of this study, the results showed that the highest tuber yield per pot were belonged to the Unit 7 and Unit 1. The best results of average tuber yield per pot (2040.52 g) for both years was Unit 7.

Table 4. Effects of different minituber size and plant material number on potato tuber yield (g)

Planting Units	Tuber Yield Per Pot (g)		
	2013	2014	Average
Unit 1	1490.0 b**	1845.88 a**	1667.94 b**
Unit 2	1757.7 ab	1609.33 ab	1683.52 b
Unit 3	1558.3 ab	1740.88 ab	1649.61 b
Unit 4	1970.0 b	1497.72 ab	1733.86 b
Unit 5	1448.3 b	1320.03 b	1384.17 c
Unit 6	1949.7 ab	1631.68 ab	1790.67 ab
Unit 7	2160.0 a	1921.04 a	2040.52 a
LSD	563.07	422.91	320.00
% CV	17.96	14.38	15.78

**: Significant at 5 % level of probability ns : non-significant

Number of minitubers and tuber yield per plant and average tuber weight are reported to be higher at low plantlet population. Whereas, total number of tubers and total tuber yield per m^2 is higher at higher plant populations [11]. It was concluded that larger minitubers increase the yield through increasing the number and size of tubers [12]. It was suggested that the number of tubers is a function of mini tubers size, the number of tubers increases by increasing mini tuber size [13]. It was suggested that the size of minitubers has a direct impact on the weight of tubers per plant. In general, small seeds have smaller leaf area index, which result in decreased photosynthetic potential [12]. The study confirmed that the Unit 6 (three small size tubers per pot) and Unit 7 (four small size tubers per pot) is the best planting unit in terms of yield and yield components.

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