Research & Reviews

ISSN: 2319-9857

Research and Reviews: Journal of Agriculture and Allied Sciences

Effect of Different Growing Materials on the Yield and Quality of Lettuce

Tuncay DEMİRER*

Celalbayar University of Alaşehir Vocatıonal School 45600, Alaşhir-MANİSA-TURKİYE

Research Article

Received: 10/02/2013
Revised: 19/02/2013
Accepted: 19/02/2013

***For Correspondence:**

Celalbayar University of Alaşehir Vocatıonal School 45600, Alaşhir-MANİSA-TURKİYE

+ 90 236 654 12 01

Keywords: Clıno,peat, perlite, coslettuce ,growıng materıal

ABSTRACT

Objective of this research was to determine the effects of different growing materials (soil, peat, clıno, perlite, woodshaving and sand) on the yield and quality of coslettuce. These materials, filled in 7 L polyethylene bags, were used as pure (4/4) or as mixture in pairs with the rations of 1/4+3/4, 2/4+2/4, or 3/4+ 1/4, resulting in 51 treatments. The experiment was arranged in a randomized complete block design, with 4 replications, a total of 204 entries. After planting, maintenance and harvest, we measured yield, plant weight, dry matter, number of leaves, width and length of leaves, bitternes, plant color, and leaf shape. Some earliness was obtained, varied with treatments. Seedlings died shortly after planting in soil + woodshaving combinations. The mixtures of perlite (3/4 or 2/4) and clıno (3/4 or 2/4) with peat (1/4 or 2/4) gave positive and important results.

INTRODUCTION

In convenient climatic conditions or in greenhouse where the ecological needs are satisfied vegetables with shorter vegetation periods takes an important role for evaluating time and area. For this reason soil-borne root disease, nematode contamination, salinity, pH inbalance, nutrient deficiency (especially for some elements), organic matter weakness, poor drainage [1], using soil not correctly, erosion, and difficulty of improving poor quality soils makes alternative medium materials attractive.

Although they are not available in mass amounts as much as soil, organic medium materials need no process, carry no weed seeds and infection components, supply high and uniform yield, need less labour and help faster growth [1,2]. Because of these advantages peat, woodshavings compost (organic materials) and sand, silt, vermiculite, perlite, rockwool, clıno, plastic foam (inorganic materials) have been used as soil regulator and will probably be used in the future [4]. Limited natural resources is a main problem for using these materials. Turkey has sufficient clıno, perlite and peat sources and also has rich sources for woodshaving and sand [1,2,5,6,7,8,9,10].

In this study clıno, perlite, woodshaving and sand were used as growing media, and soil was control.

MATERIALS AND METHODS

Lettuce cv. Yedikule was used as test plant in this research while peat, clıno, perlite, sand, woodshaving, and soil (CL) were used as seedling compost.

Research was designed in randomized block design with 51 treatments and 4 replications. Treatments were different growing materials, including peat clıno, perlite, sand, woodshaving, and soil (CL) as well as their mixtures in different ratios: 1/4+ 3/4, 2/4 + 2/4, 3/4 + 1/4 .

In this research, seedling composts were filled into 7 L black polyethylene bags. When filling the bags 2 cm margin was left from the top edge of the bags and composts were pressed slightly [1]. During the research, ammonium sulphate 21 % (150 kg $N.ha^{-1}$), tripple super phosphate 42-44 % (100 kg $P_2O_5.ha^{-1}$) and potassium sulphate 50 % (120 kg $K_2O.ha^{-1}$) were applied as beginning fertiliser [1]. During growing, drainage solutions were controlled frequently to keep pH in neutral limits [11]. On all bags 3 cm long drainage splits (3 cm from the bottom) were opened at 4 different places [1]. Bags having woodshavings and its mixtures were supplied with N (ammonium nitrate) (1% of woodshavings weight) in order to regulate the C:N ratio [12,13]. All bags, containing organic mixture, were treated with 300 cc of 10 g Benlate +40 g captan + 10 L water before planting for sterilization.

Table 1: Some Physical and Chemical Characteristics of Research Material

Analysed parameters	Soil	Woodshaving	Sand	Peat	Perlite	Clıno
Texture; particul size(mm)**	CL	0.2-1.0**	0.5-4.5**	0.2-4.5**	1-2**	1-2**
PH(1:8)*; (1:2.5)	6.8	6.1	7.01	4.2	7.09*	8.0
P_2O_5(%)	0.15	-	-	0.009	-	-
K_2O(%)	0.72	-	-	0.08	-	3.42
N (%)	0.84	0.63	-	1.08	-	-
Water Hol. Cap. (%V).	47.3	49.3	23.6	58.2	73.3	19.6
EC (mmhos/cm) 1:10	1.14	0.085	0.034	2.00	0.063	0.065
CEC (me/1 00 g)	20	-	4	65	-	6.48
Density (g/cm^3)	1.15	0.19	1.66	0.59	0.19	0.79
Porosity (%)	57.96	85.82	38.81	69.28	79.37	74.25
Lime(%)	9.24	-	2.17	4.78	0.682	0.124
Useful water (%)	13.1	13.7	0.93	29.6	8.13	3.12

Inorganic bags (because their CEC is low) were fed daily [11,13] while organic bags were fed every two days with 1 L bag^{-1} of polyfeed fertilizer (0.8/1000 diluted) containing N:159, P_2O_5: 154, K_2O:154, Fe:0.8, Mn:O.4, Zn:1.2, Cu:0.88, B.0.16, Mo:0.7 . Plants were irrigated with distilled water in the mornings. Distilled water was used to prevent physiological drought [13].

On 11.07.2012 plants at maturity were harvested after irrigation and injured roots and leaves were removed. in harvested plants, yield (kg ha^{-1}) was obtained with conversion of plant weight to hectare, leaf number (number) by counting the leaves, leaf width and length (cm) by measuring the middle leaves with compass, dry matter (%) with refractometer, plant colour (light green or dark green) with observation, leaf shape related to width and length as wide-sphere or long sphere [1] and bitterness by tasting. Data were evaluated with variance analysis and compared with Duncan grouping [14]. A correlation analysis was run to detect possible associations among the traits studied.

RESULTS AND DISCUSSION

Duncan grouping obtained from variance analysis was shown at table 2 and correlation at table 3.

With the positive effect of temperature and continuous nutrition, test plants reached harvest maturity 44 days after transplanting and by this 20-25 days earliness was obtained.

Seedlings in soil + woodshaving combinations (19,20 and 21 treatments) died in all replications. This can be explained with the salinity problem caused by rapid decomposition of woodshavings with irrigation and nutrient solution. Revealed organic formations resin and cellulose cause infections in the roots [13].

Yield changed between 3812,50-84384,00 $kg.ha^{-1}$ and research average was 44040,59 $kg.ha^{-1}$ (Table 2). The highest yield was obtained from 2/4 perlite+2/4 peat combination with 84384.00 $kg.ha^{-1}$, followed by perlite + sand and perlite + clıno combinations. The lowest yields were obtained from 4/4 woodshaving and woodshaving combinations. This can be explained by the fact that the nitrogen given at the beginning was not sufficient due to high *C/N* ratio (1000/1); relative osmotic potential or physiologieal drought resulting in insuffieient nutrients to the plants, and poor airation conditions due to high water absortivity [13].

Yields, obtained from 4/4 ratios of woodshaving, sand, perlite, sand and clıno were 4883, 24102, 25649, 33689, 42932 and 52138 $kg.ha^{-1}$ respectively. in mixtures; soil + clıno (no 7,8 and 9 treatments) yielded approximately 40000 $kg.ha^{-1}$ and did not change with treatments. In perlite and peat mixtures of soil (no 10-15 treatments) yield increased as peat and perlite ratio increased in the mixture. This can be explained with ideal characteristics (easy water absorption, porosity, water holding capacity etc.) of perlite and peat [15].

In clıno combinations, yield was higher in perlite, peat and woodshaving mixtures (no 23, 26 and 32 treatments) of 2/4+2/4 ratios. In the combinations where the ratio of clıno was decreased to 1/4+3/4 (no 24, 27 and 33 treatments) yield fell down.

Yields increased in the mixtures of peat and sand's 2/4+2/4 ratios but decreased (no 36 and 39 treatments) in the ratios which perlite amounts were low. With increase in the rates of woodshavings and sand (no 40-45 treatments) yield decreased continuously in the mixtures of perlite + woodshavings and peat + sand. This is because increasing amounts of woodshavings decrease the airation and especially if the mixture rate is over 20% it causes salinity [13]. The increasing amounts of sand cause insufficient nutrient problems because of easy leaching and non-buffering [13]. In the mixtures of peat + woodshavings the yield increased with 2/4 peat ratio, compared to ýý mixes, but decreased with % ratio, due to low airation caused by peat. There was no correlation between yield and mixture rates in the mixtures of sand + woodshavings (Table 2).

Yield increased in the mixtures of perlite, because adsorption of nutrients given, high airation capacity, high water holding capacity and easy control of changes in pH. Clıno, peat, soil, sand and woodshaving followed perlite in the given order. Because clıno has low porosity compared to perlite cations are not released as easily as in perlite, also water cannot be taken with capilarity so roots cannot grow comfortably. These factors resulted in lower yields in peat and its mixtures, compared to perlite. Peat mixtures ranked third. Highly significant positive correlation were determined between yield and plant weight, dry matter, leaf number, leaf width and length (Table 3).

Similar to the yield, perlite and clıno also gave the best results on plant weight. For peat, soil, sand, woodshaving and paired mixtures of these, higher yields were observed in those mixtures which had high inorganic material content than organic material content (Table 2). Table 1 shows the values closest to the standards needed in the optimum growing conditions, determined by De Boodt and Verdock [16], can be obtained from perlite + peat. The mean plant weight was 330.25 g and the highest value was 632.90 g plant^{-1} from the mixture of perlite and peat. The high values obtained in this re search can be explained by the positive effects of climate (temperature and moisture), the difference in binding up the bulb [17], faster growth with high temperatures and continuous feeding.

Dry matter was determined higher on the lower values of plant weights (organic based mixtures) in contrast to the yield and plant weight. However the mean dry matter for the research was 4.41 % ranging between 1.0-6.2 %. Important correlations were found between dry matter and leaf number, and width and length (Table 3). The high dry matter content obtained in the organic based mixtures can be explained by the physicochemical relations between medium and the plant; the period before nutrients are absorbed by the plant and the positive effect of organic character to the plant.

For leaf number, the highest value was 79 and the mean was 47. Mixtures of peat and perlite took the first place according to Duncan test. Clıno, soil, sand and woodshaving followed perlite (Table 2). Positive correlation were determined between the leaf number and leaf width and length at %1 level (Table3). The abundance of the number of leaves was a measure of the speed and amount of vegetative growth [18]. This is supported by the fact that perlite, peat and clıno have low density and high porosity, resulting in better development of roots and thereby better use of fertilizer and nutrient solution. The opposite of this is the case in the mixtures made of soil and sand, the negativeness of maturation and separation in woodshavings cause the results to be low.

The mean of the width of leaves was 11.64 cm and these values ranged between 15.82-75.00 The differences between treatments were found to be important at 1% level and the mixtures of perlite took the first place; clıno, peat, sand and woodshaving followed the perlite mixtures according to the multiple tests (Table 2). A positive significant correlation was found between leaf width and leaf length (1 %). The results of the leaf length and width were found parallel, also these

Bitterness is the sign of nitrate accumulation which is higher than 10 % of the total dry matter in the vegetables like spinach, lettuce, etc [19]. Nitrate accumulation in plants is related to the factors like the amount and form of N used, light intensity, moisture of soil, photoperiod, and concentration of CO_2 [20] . Among these, the most important ones are N amount and form because insufficient assimilation of nitrate and using nitrate in high amounts incite nitrate accumulation [19]. So the fertilizers as sources of nitrogen were chosen from the fertilizers whose N contents were in the form of NH_4, as a result no bitterness were determined in the treatments (Table 2).

The colour of the plant was dark green in the organic based mixtures and changed to green two parameters can be explained by the relationships between nutrients, plant and environment. and light green as inorganic material in the mixtures increased (Table 2).

The plants were named as long-sphere in shape when the leaf lengths were higher than the leaf width [21]. All leaves were long-sphere in this study (Table 2).

Research& Reviews

ISSN: 2319-9857

Table 2: Duncan Grouping of Research Data

Treatments			Yield (kg.ha⁻¹)		Plant Weight (g-plant⁻¹)		Dry Matter (%)		Leaf Number (Nm.plnt⁻¹)		Leaf Width (cm)		Leaf Length (cm)		Bitt. Ness (+,-)	Plant Color	Leaf Form
1	Soil	4/4	33688,75	j-s	252,67	g-n	5,02	a-g	46,75	c-j	10,25	c-g	20,00	a-g	+	DG	LS
2	Clıno	4/4	52138,25	a-n	391,05	a-j	4,25	c-h	50,00	a-ı	11,50	a-g	17,25	b-h	+	DG	LS
3	Perlite	4/4	25648,75	l-s	192,37	l-n	5,82	a-c	35,50	f-k	10,62	b-g	17,12	b-h	+	LG	LS
4	Peat	4/4	42931,75	c-o	322,00	c-k	5,42	a-f	51,75	a-ı	13,00	a-e	20,00	a-g	+	DG	LS
5	Sand	4/4	24102,00	m-s	136,22	j-n	5,50	a-e	44,50	d-j	9,75	d-g	15,62	d-ı	+	LG	LS
6	W.shv	4/4	4882,50	p-s	41,62	l-n	1,00	l	18,75	j-l	7,50	g	10,00	ı	+	LG	LS
7	Soil	3/4-1/4	40182,00	e-o	301,37	e-l	4,40	b-h	38,75	f-k	12,00	a-g	20,50	a-g	+	G	LS
8	+	2/4-2/4	41741,75	d-o	313,07	d-k	4,20	c-h	51,50	a-ı	11,37	a-g	17,00	b-h	+	G	LS
9	Clıno	1/4-3/4	38250,25	g-p	280,15	f-m	4,07	e-h	48,00	b-ı	12,87	a-e	19,12	a-g	+	DG	LS
10	Soil	3/4-1/4	39771,75	f-o	298,30	e-l	4,30	c-h	46,25	c-j	12,50	a-g	21,62	a-d	+	DG	LS
11	+	2/4-2/4	45725,25	c-o	342,95	c-k	3,27	h	47,25	c-j	14,25	a-e	22,75	a-c	+	G	LS
12	Perlite	1/4-3/4	52624,75	a-m	394,70	a-j	4,65	a-h	55,75	a-ı	13,00	a-e	21,37	a-e	+	LG	LS
13	Soil	3/4-1/4	37292,00	h-r	279,70	f-m	5,45	a-e	55,00	a-ı	11,62	a-g	20,12	a-g	+	DG	LS
14	+	2/4-2/4	43411,75	c-o	325,60	c-k	4,65	a-h	51,50	a-ı	11,50	a-g	20,00	a-g	+	DG	LS
15	Peat	1/4-3/4	45100,00	c-o	338,60	c-k	5,07	a-g	50,25	a-h	12,62	a-f	18,62	a-g	+	DG	LS
16	Soil	3/4-1/4	33802,00	l-s	253,52	g-n	4,87	a-h	48,50	b-ı	11,25	a-g	17,87	b-g	+	DG	LS
17	+	2/4-2/4	28472,00	l-s	213,55	l-n	5,30	a-f	43,50	e-j	11,12	a-g	18,50	a-g	+	G	LS
18	Sand	1/4-3/4	26185,25	l-s	196,40	l-n	4,60	a-h	38,50	f-k	11,50	a-g	18,50	a-g	+	LG	LS
19	Soil	3/4-1/4	-	-	-	-	-	-	0,00	–	0,00	-	0,00	-	-	-	-
20	+	2/4-2/4	-	-	-	-	-	-	0,00	–	0,00	-	0,00	-	-	-	-
21	W.shv	1/4-3/4	-	-	-	-	-	-	0,00	–	0,00	-	0,00	-	-	-	-
22	Clıno	3/4-1/4	58502,50	a-l	438,92	a-ı	4,25	c-h	49,25	b-ı	15,25	a-c	23,00	a-b	+	G	LS
23	+	2/4-2/4	72657,75	a-f	544,95	a-e	3,57	g-h	60,50	a-f	14,62	a-e	22,25	a-c	+	G	LS
24	Perlite	1/4-3/4	59821,50	a-l	451,17	a-ı	3,92	e-h	53,00	a-ı	14,00	a-e	19,87	a-g	+	LG	LS
25	Clıno	3/4-1/4	69113,50	a-h	518,37	a-f	6,90	e-h	60,75	a-f	13,37	a-e	21,00	a-f	+	G	LS
26	+	2/4-2/4	71701,25	a-g	537,77	a-f	4,67	a-h	54,50	a-ı	15,37	a-b	22,12	a-c	+	DG	LS
27	Peat	1/4-3/4	67618,00	a-ı	507,15	a-g	4,25	c-h	55,00	a-ı	14,12	a-e	22,50	a-c	+	DG	LS
28	Clıno	3/4-l/4	64284,50	a-k	482,15	a-h	4,47	b-h	57,00	a-h	13,00	a-e	22,25	a-c	+	G	LS
29	+	2/4-2/4	67771,25	a-j	500,80	a-g	5,05	a-g	56,75	a-h	11,62	a-g	20,37	a-g	+	G	LS
30	Sand	1/4-3/4	76480,00	a-c	583,72	a-c	5,10	a-g	69,25	a-e	13,87	a-e	19,62	a-g	+	LG	LS
31	Clıno	3/4-1/4	42911,50	c-o	321,85	c-k	5,27	a-g	50,25	a-ı	15,37	a-c	22,00	a-c	+	G	LS
32	+	2/4-2/4	47861,50	b-o	358,97	b-k	5,02	a-g	50,00	a-ı	13,00	a-e	20,87	a-f	+	G	LS
33	W.shv	1/4-3/4	43881,75	c-o	329,12	c-k	4,10	e-h	46,25	c-j	12,50	a-g	22,50	a-c	+	LG	LS
34	Perlite	3/4-1/4	75414,25	a-d	573,52	a-d	4,30	c-h	59,50	a-g	14,75	a-e	20,12	a-g	+	G	LS
35	+	2/4-2/4	84384,00	a	632,90	a	3,72	f-h	70,25	a-e	15,00	a-c	21,75	a-d	+	DG	LS
36	Peat	1/4-3/4	73829,00	a-e	565,62	a-d	3,82	e-h	70,00	a-e	15,82	a	24,25	a	+	DG	LS
37	Perlite	3/4-1/4	81817,75	a-b	613,65	a-b	3,80	e-h	74,00	a-c	14,25	a-e	21,15	a-f	+	G	LS
38	+	2/4-2/4	84357,25	a	632,70	a	3,95	e-h	78,75	a	15,00	a-d	23,00	a-b	+	LG	LS
39	Sand	1/4-3/4	43868,75	c-o	329,02	c-k	4,75	a-h	56,00	a-ı	11,87	a-g	19,00	a-g	+	LG	LS
40	Perlite	3/4-l/4	17872,50	n-s	132,72	j-n	5,27	a-g	30,25	h-k	10,75	b-g	15,62	d-ı	+	G	LS
41	+	2/4-2/4	16266,00	o-s	122,00	k-n	4,12	d-h	27,75	l-l	10,50	b-g	15,00	f-ı	+	G	LS
42	W.shv	l/4-3/4	3812,75	r-s	28,600	m-n	6,10	a-b	13,25	k-l	7,6	f-g	11,00	h-ı	+	LG	LS
43	Peat	3/4-1/4	63711,25	a-h	507,85	a-g	5,80	a-d	72,00	a-d	12,37	a-g	19,37	a-g	+	DG	LS
44	+	2/4-2/4	41520,75	d-o	311,42	d-k	6,20	a	63,25	a-f	9,62	e-g	16,62	c-h	+	G	LS
45	Sand	1/4-3/4	41711,75	c-o	312,85	d-k	4,40	b-h	76,00	a-b	11,62	a-g	17,50	b-g	+	LG	LS
46	Peat	3/4-1/4	54151,50	a-m	406,15	a-ı	4,60	a-h	58,25	a-h	12,12	a-g	19,75	a-g	+	DG	LS
47	+	2/4-2/4	68804,25	a-h	516,05	a-f	3,90	e-h	55,75	a-ı	14,62	a-e	24,37	a	+	DG	LS
48	W.sbv	1/4-3/4	17695,75	o-s	123,85	k-n	4,60	a-h	31,50	g-k	9,62	e-g	15,12	e-ı	+	G	LS
49	Sand	3/4-1/4	32232,25	k-s	241,75	h-n	6,10	a-b	53,25	a-ı	11,37	a-g	16,75	c-h	+	LG	LS
50	+	2/4-2/4	18162,50	n-s	134,05	j-n	6,10	a-b	30,25	h-k	10,50	b-g	14,37	g-ı	+	LG	LS
51	W.shv	1/4-3/4	27902,25	l-s	209,27	l-n	5,30	a-f	47,00	c-j	12,00	a-g	20,50	a-g	+	LG	LS
Avareges			44040,59	**	330,25	**	4,41	**	46,67 ** (47)		11,64	**	18,22	**			

**; P<0.01, +; no bitter, -; bitter, DG; Dark green, G; green, LG; Light green, LS; Long -Sphere

Table 3: Correlations about Evaluated Parameters

Parameters	Plant Weight	Dry Matter	Leaf Number	Leaf Width	Leaf Length
Yield	0.996**	0.205**	0.678**	0.629**	0.650**
Plant Weight		0.194**	0.674**	0.628**	0.644**
Dry Matter			0.396**	0.463**	0.512**
Leaf Number				0.637**	0.681 **
Leaf Width					0.910**

**:p<0.0l

SUMMARY

There are some advantages and disadvantages of the materials used as medium. Use of mixtures is inevitable to combine the advantages and to eliminate the disadvantages. Thus, perlite mixtures yielded very good results, whereas bags filled with 4/4 perlite did not. Optimum conditions were accomplished by using small amounts of the materials that have no problems of separation, purification and maturization (e.g. peat), and by using large amounts of the inorganic materials in mixtures. In addition, considering water and nutrient sayings, use of inorganic materials, such as perlite and clıno (3/4 or 2/4) mixed with peat with the ratios of (1/4 or 2/4) is recommended over the use of soil, sand, peat, and woodshaving.

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