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The effect of planting date and depth on the yield of potato cultivars in winter cultivation in Jiroft region

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Abstract

In order to investigate the effect of different winter planting dates at two planting depths on the yield characteristics of potato cultivars, an experiment was carried out in the agricultural year of 2017-2016 in the teaching and research farm of Jiroft Branch Islamic Azad University, in the form of double split plots in the form of randomized complete blocks in four The repetition was executed. The main factor was cultivar (bamboo, Colombo and Sante), the sub-factor was planting depth (10 and 20 cm) and the sub-factor was planting date (21 December, 10 and 30 January). The results showed that the planting dates of December and January are superior in terms of total yield, yield of large tubers (larger than 55 mm), seed tubers (35-55 mm) and small tubers (smaller than 35 mm). It is significant compared to the planting date of December. By increasing the planting depth from 10 to 20 cm, the total performance and the performance of large tubers increased significantly, and no significant difference was observed in other cases. The amount of total yield was 40.39 tons per hectare and the yield of large tubers was 27.84 tons per hectare in the bamboo cultivar with a statistically significant difference more than the other two cultivars. Investigating the growth and development of plants showed that the earliest time of tuber formation in plants was cultivated in December and the latest in plants was cultivated in December. The number of aerial stems in the plants cultivated in December was also less than the plants in January. Also, December cultivation did not result in early harvest.

***Keywords*:** potato, endosperm, seed tuber, main stem, yield

Introduction

The appropriate planting date makes the total environmental factors at that time suitable for the establishment and survival of the seedling, and each stage of growth meets its own favorable environmental conditions. Usually, the most suitable planting date leads to the maximum yield of the crop, compared to other planting dates. Considering that the climatic conditions of each region are different and on the other hand, different cultivars of the same species have different reactions, it is necessary to determine the suitable planting date for each cultivar according to the climatic conditions, characteristics of the cultivar, and the purpose of planting (Khajepour 1995, Vaezian 1998).

In general, the date of planting potatoes can be determined based on the length of the growing season for potatoes in each region. In areas like Isfahan, where the length of the growing season is limited, it is necessary to

choose the planting date in such a way that, as much as possible, the period of tuber formation and tuber growth does not come into contact with hot weather (about 25 degrees Celsius and more), and on the other hand, cold is also a limiting factor. Not for greening and growth after planting (Khajepour 1999; Mortazavi Bek 1999). The studies that have been done on the planting date indicate that the planting date is effective on the trend of the leaf area index as well as the amount of radiation absorbed in the vegetation and is ultimately an important factor in determining the yield of potatoes, so that a delay in the planting date is suitable for any region, it causes a decrease in yield. (Mackerron and waister. 1995. Beukema and vander zaag. 1999) The studies carried out in our country show the possibility of autumn potato cultivation in some regions (Abasifar et al. 2014). Eslami 1368), investigated the possibility of autumn planting in Isfahan and reported that Romano Baraka, Aola, Etzieba, Anosta and Cosima cultivars are suitable for autumn planting in the region. Planting depth plays a major role in the formation of stolens and aerial stems, so that with increasing planting depth (up to 20 cm depending on the agricultural conditions), the number of stolens and finally the yield increases (Vandcr Zung, 1992, (Bruton, 2002). The results of the investigations carried out in the Central Province also showed that increasing the planting depth to 15 cm increased the number of aerial stems and yield, and increasing the planting depth to 25 cm and more resulted in a decrease in the number of aerial stems and yield. (Abbasi Far et al., 1994).

Research Objective

It included checking the date of winter planting in order to achieve maximum production in suitable sizes in commercial cultivars and checking the planting depth in order to achieve maximum production in suitable sizes.

Materials and Methods

This study was carried out in the agricultural year of 2015-2016 in the teaching and research farm of Islamic Azad University, Jiroft Branch, located in Khezrabad. The studied cultivars were Bamboo, Colombo and Sante. The tested land was fallow in the year before cultivation. Based on the measurements made up to the depth of 30 cm, the percentage of sand, silt and clay in the tested plots is 16, 50 and 34, respectively, the electric conductivity of the saturated soil extract is 2.4 dS/m, the acidity of the soil is about 7.7 And the amount of soil nitrogen based on organic carbon was about 0.1%, and available phosphorus and potassium were determined as 27.4 and 325 parts per million, respectively. Before planting and during the period, according to the relevant fertilizer recommendations, 400 kg of urea fertilizer was used, 1/4 of which was used before planting and the rest in 2 times during the period, one when soiling and the other around 10 days later, it was applied along with irrigation and due to lack of need, phosphorus and potash fertilizers were not used. Also, 40 kg per hectare of zinc sulfate was used before planting. Before planting, at the rate of 30 tons per hectare, rotted animal manure was mixed with the soil in order to improve the physical properties of the soil. The experiment was carried out in the form of double split plots in the form of randomized

complete blocks in four replications. The main factor was the variety including 3 varieties of bamboo, colombo and Sante, the sub-factor was planting depth at 2 depths of 10 and 20 cm, and the sub-factor was the date of planting, which included 3 dates, 30 Azar, 20 December and 10 Bahman, respectively. Each treatment consisted of 4 planting lines with a length of 5 meters, the distance between the rows was 75 cm and the distance between the plants on the row was 20 cm. Class E seed tubers with a diameter of 35 to 55 mm were used for planting. The tubers planted on December 30 were naturally in the dormant stage, but the tubers planted on December 20 and February 10 were stored in a standard warehouse with a temperature of 4 degrees Celsius and a relative humidity of 85 to 90 percent with proper ventilation and Sufficient light (effective light after the breaking of the sleeping period) was maintained so that when planting, they were at the appropriate stage in terms of physiological age and had several thick and firm buds (multi-bud stage) (Mortazavi Beck. 1397, Beukema 1999) and Vander Zaag). During the period, the necessary operations such as irrigation, tilling, fertilizing, weed control were carried out when necessary. Note that the growth stages were taken every 3 days. In order to determine the time of the beginning of tuber growth, a number of 10 plants were randomly selected from each plot and after determining the growth stage of each, their average was considered as the tuber growth stage of that treatment. Also, in order to estimate the beginning of flowering in 50% of the plants of each treatment (the beginning of the opening of the petals), a note was taken of all the plants in the two middle lines of each treatment. In order to calculate the number of main aerial stems per plant, the main stems of 10 consecutive plants were counted from the middle of one of the two middle lines of each treatment at the end of the growing season. To calculate the total yield, the yield of tubers obtained in small (smaller than 35 mm), seed (35 to 55 mm) and large (larger than 55 mm) sizes of the samples from the length of 4 meters consecutively in the middle of the two middle lines of each Crete was removed. The results of performance characteristics were subjected to analysis of variance and the averages were compared by Duncan's multiple range test.

Results and Discussion

Examining the stages of growth and development The time of tuber formation and flowering of the treatments in this experiment followed a similar pattern. The date of the beginning of tuber formation and the beginning of flowering in 50% of the plants of each treatment is presented in table 1, it is carefully deduced from this table that the time of the beginning of tuber formation at the same depth and date of cultivation is different between cultivars, so that the reproductive tuber in Colombo started a little earlier than bamboo and in Sante later than the other two varieties. Planting depth had no effect on the initiation of gonads. The earliest tuber formation time of cultivars was on January 20th and the latest one was on Azar 30th. It seems that the use of pre-germinated seed tubers on the planting dates of January 20 and Bahman 10 has accelerated tubers and increased the yield. The process of the beginning of flowering in the experimental treatments was almost similar and in the beginning of May, which shows that the

initiation of flowering in the plants was less influenced by the experimental treatments and more influenced by the photoperiod. The plants cultivated on December 30 turned green about a week later than the plants cultivated on December 20. It is obvious that the earlier sprouting of the tubers planted on December 20 compared to December 30 is due to the pre-sprouting process that was carried out in the tubers planted on December 20 under favorable storage conditions.

Table 1: Dates of tuber growth and flowering in different treatments

Varieties	Depthof planting	Dateof planting		Tuberizing		50% Flowering
		21 Dec	21.598	01/02/2017	21.598	01/03/2017
Bamboo	10	10 Jan	12.598	23/01/2017	24.598	04/02/2017
		30 Jan	19.598	30/01/2017	25.598	05/02/2017
	20	21 Dec	19.598	30/01/2017	19.598	30/02/2017
		10 Jan	11.598	22/01/2017	22.598	02/02/2017
Colombo	10	30 Jan	12.598	23/01/2017	25.598	05/02/2017
		21 Dec	18.598	29/02/2017	23.598	03/02/2017
	20	10 Jan	10.598	21/01/2017	24.598	04/02/2017
		30 Jan	13.598	24/02/2017	24.598	04/02/2017
		21 Dec	13.598	24/02/2017	22.598	02/02/2017
	10	10 Jan	9.598	20/01/2017	25.598	05/02/2017
		30 Jan	10.598	21/01/2017	23.598	03/02/2017
		21 Dec	24.598	04/02/2017	25.598	05/02/2017
Sante	20	10 Jan	14.598	25/01/2017	24.598	04/02/2017
		30 Jan	23.598	03/01/2017	27.598	07/02/2017

Analysis of the variance of the number of aerial stems at different levels of cultivar, depth and planting date was significant. (Table 2) so that Sante, Colombo and Bamboo cultivars had the highest to lowest average number of aerial stems per plant respectively. Table (3) comparing the two planting depths, the average number of aerial stems per plant at a depth of 20 cm The significance was greater than the depth of 10 cm (Table 4). In the experiment of Abbasi Far et al. (1374), among the planting depths of 5, 15, 25 and 35 cm, the highest number of aerial stems was obtained from the depth of 15 cm. The average number of aerial stems in the plants cultivated on December 30 compared to the plants cultivated on January 20 and Bahman 10 was at a statistically lower level, but there was no significant difference between the two dates of January 20 and Bahman 10 (Table 3) during an experiment in North Africa. Also, the number of aerial stems per plant is reported to be higher in spring cultivated plants than in autumn cultivated plants (Fahem and Haverkort, 2010). Abbasifar et al. (1374) also reported an increase in the number of aerial stems in plants cultivated in spring compared to autumn cultivated in Central Province. Because the pre-sprouting process increases the number of aerial stems. (Mortazavi Bek, 1397). (Beukema and Van der Zaag, 1999 Probably, the increase in the number of aerial stems in plants cultivated in winter compared to autumn cultivation is due to the pre-germination done in tubers planted in winter cultivation. The stage of tubers ripening (hardening of the skin) and the harvest time, June, were almost the same in all three planting dates, and in general, the tubers of

the bamboo variety could be harvested about a week earlier than the other treatments. Check performance characteristics The composite variance analysis of total yield, small seed tubers and large tubers at different levels of cultivars showed that all of them are significant at the 1% level (Table 2). According to Table 3, it can be seen that the average total yield is 40.39 tons per hectare and The yield of large tubers was 27.84 tons per hectare in the bamboo cultivar with a statistically significant difference more than the other two cultivars. Culumbo variety had the lowest and Sante variety had the highest yields of small tubers and seeds. Variance analysis of yield characteristics in planting depths in the case of total yield and large tubers was significant at the 5% level and in other cases there was no significant difference (Table 2) so that with the increase of planting depth from 10 to 20 cm, the average yield Total and large tubers increased with a significant difference .

Table 2: Analysis of composite variance test on performance characteristics of aerial main stems

		Means of Squares(MS)				
S.O.V.	**df**	**Total yield (<35mm)**	**Small tubers (35-55mm)**	**Seed tubers (>55mm)**	**Large tubers**	**Main Stems**
Year (Y)	1	9168.06^{ns}	2312.01*	459345.06**	660156.25**	0.09^{ns}
R (Y)	6	12193.58	301.11	761.91	6894.56	0.08
Cultivar (A)	2	32551.51**	3460.67**	11367.76**	51825.08**	10.47**
A×Y	2	23496.52**	338.55^{ns}	803.81^{ns}	23409.08^{ns}	0.17^{ns}
R(A×A)	12	1674.53	91.46	856.11	1940.98	0.48
Depth (B)	1	7788.06*	0.84^{ns}	16.67^{ns}	7084.03*	1.71**
BB×Y	1	4455.56^{ns}	327.01^{ns}	3570.06*	12.25^{ns}	0.43^{ns}
A×B	2	3579.94^{ns}	490.63*	516.05^{ns}	3624.36^{ns}	0.09^{ns}
A×B×Y	2	2333.31^{ns}	8.59^{ns}	58.19^{ns}	2416.08^{ns}	0.13^{ns}
R(Y× A×B)	18	1648.35	118.55	534.68	1295.71	0.18
Date (C)	2	38125.72**	2635.84**	12814.84**	2024.02^{ns}	3.74**
C×Y	2	11859.02**	286.09*	1703.77**	9287.02**	2.55**
A×C	4	6990.07**	973.13**	1330.77**	10859.79**	0.22^{ns}
B×C	2	4245.65*	591.59**	756.05*	1921.88^{ns}	0.19^{ns}
A×C×Y	4	16977.10**	108.26^{ns}	2840.30**	10881.92**	0.20^{ns}
B×C×Y	2	1894.65^{ns}	283.17^{ns}	1575.81**	228.77^{ns}	0.80^{ns}
A×B×C	4	176.58^{ns}	11.69^{ns}	140.08^{ns}	128.72^{ns}	0.22^{ns}
A×B×C×Y	4	4780.40**	230.32**	419.53^{ns}	4018.60*	0.17^{ns}
Error	72	1145.14	60.55	232.33	1243.48	0.21
% C.V.		9.02	17.07	14.67	14.34	17.12

ns: non significant *: significant at 5% level **: significant at 1% level R:Recplication
R(Y×A) AND R(Y×A×B) are used as error for test of cultivar and depth respectively

Table 3: Comparison of the average number of main stem and yield characteristics between cultivar levels, depth and planting date

Factor	Level	Main stems Per plant	Total yield (tha^{-1})	Small tubers (tha^{-1})	Seed tubers (tha^{-1})	Large tubers (tha^{-1})
Cultivar	Bamboo	2.16 c	40.39 a	2.23 b	10.32 b	27.84 a
	Colombo	2.63 b	35.30 b	1.75 c	8.89 c	24.65 b
	Sante	3.18 a	36.87 b	3.40 a	11.97 a	21.67 c
Plantingdepth	10 cm	2.49 b	36.78 b	2.46 a	10.4 a	25.29 a
	20 cm	2.82 a	38.26 a	2.47 a	10.36 a	25.29 a
Planting date	21 December	2.15 b	34.30 b	1.62 b	8.51 b	23.96 a
	10 January	2.88 a	39.54 a	3.01 a	11.26 a	25.26 a
	30 January	2.95 a	38.72 a	2.75 a	11.41 a	24.54 a

Means with the same letters in each column are not statistically significant at the 5% level (Duncan's multiple range test)

The superiority of the yield at the depth of 15 cm was not significant compared to the depth of 5 and 25 cm, and there was no significant difference between the planting depths in terms of the yield of seed tubers. During an experiment between two planting depths of 25 and 15 cm, 25 cm depth was found to be more suitable for fall planting in the weather conditions of Faridan region of Isfahan (Mortazavi, 2017, Darabi and Hassanabadi (2017), during experiments in Behbahan with comparison Three planting depths of 10, 15 and 20 cm, the best potato planting depth for autumn cultivation in Khuzestan province was reported to be 15 cm. In the experiment of Abbasifar et al. (1374) among planting depths of 5, 15, 25 and 35 cm, the increase in yield was significant at a depth of 15 cm compared to a depth of 35 cm, but the analysis of the variance of yield characteristics in planting dates in all Except for the yield of large tubers, it was significant at the level of 1% (Table 2), so that the average yield of all small tubers and seeds in the two planting dates of December 20 and Bahman 10 was higher than the planting date of Azar 30 without any significant difference (Table 3).). Similar results have been reported in the comparison of autumn and spring potato cultivars in North Africa. Seed tubers (Fahem and Haverkort, 2020) Abbasi Far et al. they got More aerial stems that are obtained as a result of pre-sprouting increases the potential of forming underground stems and thus the potential of production (Khajepour, 2002; Bruton, 2002). The interaction effect of cultivar on planting depth was significant only for the yield of small tubers at 5% level, but the interaction effect of cultivar on planting date was significant at 1% level for all yield characteristics. Table (2) which shows the different reaction of each variety in each planting date. Table 4 compares the yield averages of the cultivars at different levels of planting dates. From the results of this table, it can be concluded that the yield of the bamboo variety on two dates, 20th of December and 10th of Bahman, is favorable, planting on 10th of Bahman with an average yield of 43.75 tons per hectare has the highest tuber yield, and the lowest tuber yield is related to the Columbo variety in The sowing date was 30 Azar, although the Sante variety also had a low yield on this date. The highest yield of Colombo and Sante cultivars was related to the sowing date of 20th of

December. It should be mentioned that the yield of 30 Azar bamboo cultivation with an average of 36.84 tons per hectare has shown superiority compared to the fall cultivation of two other cultivars. Table 5 shows the average yield of seed tubers of cultivars at different levels of planting dates. According to this table, it can be concluded that the variety Sante has the highest seed tuber yield of about 13 tons per hectare on the planting dates of 20th of December and 10th of Bahman, although there is a difference with the yield of the seed tuber of the Colombo variety on the planting date of 20th of December. It has not shown any significance. The lowest yield of seed tuber was related to Columbo cultivar on the planting date of 30 Azar. In general, the examination of the results in this experiment showed that the planting dates of 20th of December and 10th of Bahman had the possibility of breaking the dormancy to achieve the appropriate physiological age and pre-germination of the seed tubers, and the number of aerial stems and yield increased. And the planting date of January 20 is recommended in Jiroft region. Planting 20 cm increases the total yield and large tubers and the produced product is more marketable due to the large size of the tubers. As a result, the planting depth is 20 cm in soils that are not too heavy and have been amended with the use of organic fertilizers. It is recommended for Jiroft area. Also, according to the results of this research, the bamboo variety is one of the superior and recommended varieties due to its higher yield.

Table 4: Comparison of the average yield of the cultivars at different levels of planting dates

	Planting Date		
Cultivar	21 Dec	10 Jan	30 Jan
Bamboo	36.84 cd	40.44 b	43.75 a
Colombo	31.09 c	38.32 bc	36.49 cd
Sante	34.84 d	39.85 b	35.93 cd

Means with the same letters in each column are not statistically significant at the 5% level (Duncan's multiple range test)

Table 5: Comparison of the average yield of seed tubers (tha^{-1}) of cultivars at different levels of planting dates

	Planting Date		
Cultivar	21 Dec	10 Jan	30 Jan
Bamboo	8.89 d	11.66 ab	10.30 bcd
Colombo	6.94 c	8.93 d	10.80 bc
Sante	9.69 cd	13.09 a	13.13 a

Means with the same letters in each column are not statistically significant at the 5% level (Duncan's multiple range test)

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