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The Durum Wheat Gene Sequence Response Assessment of *Triticum durum* for Dehydration Situations Utilizing Different Indicators of Water Deficiency

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ABSTRACT

In the following research, forty durum wheat gene sequences (Triticum durum) were evaluated in water tensioned and also enough-watered conditions in three years 2015 till 2018 product years. In every surrounding, the gene sequences were estimated utilizing the whole block models that are chosen accidentally by 3 iterations. From the data of the seed product, dehydration endurance indicators including STI, SSI, GMP, MP, TOL, YSI and YI have been measured for each gene sequence. The yielding has investigated as attained from a whole block model that is chosen accidentally. Considerable variations between gene sequences have been recognized for the indicators of the whole dehydration endurance. Large product amount in tension was presented by gene sequence 'Genotype NO.40 and non-tension surroundings was presented by and 'Genotype NO.32'. The highest amount of STI, MP and GMP indicators have related to gene sequence 'Genotype NO.35'. The largest amount of YI has been from gene sequence 'Genotype NO.39' and 'Genotype NO.21'. Association ratios showed that TOL, MP, GMP, STI, HM, and YI indicators can efficiently be utilized to screen the dehydration endurance gene sequence. Utilizing MP, GMP, TOL, YI and STI indicators, gene sequence UPGMA assortment has been accomplished and 3 groups have been initiated where matched the bi-plot investigation outcomes. in this investigation, by considering the outcomes, Genotype NO.10 and Genotype NO.35 was the maximum dehydration endurance gene sequence that was classified as cluster A. endurance indicators containing STI, GMP, and MP are appropriate for wheat dehydration endurance gene sequence choice has been proposed.

KEY WORDS: BI-PLOT, MULTI-VARIABLE INVESTIGATION, WATER DEFICIT, TRITICUM DURUM DESF, PRODUCT DURABILITY.

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INTRODUCTION

In the current time, Nouri and co-workers in 2011 have represented that durum wheat has been raised often in the Mediterranean rainy regions under the situations that are full of tension and unsteady environment (Gholamin and Khayatnezhad, 2020a). Leilah and co-workers in 2005 have illustrated that producing the high production cultivars of the wheat under dehydration situations in dry and semi-dry areas is a significant purpose of breed programs. Giunta et al (1993); Simane et al (1993); Gholamin and Khayatnezhad (2020b) Abayomi and Wright (1999) have represented that the tension of dehydration could decrease the whole product ingredients, however especially the number of clusters that are productive per unit region and the number of seeds per cluster (Gholamin and Khayatnezhad 2012, Khayatnezhad and Gholamin 2012, Gholamin and Khayatnezhad 2020, Gholamin and Khayatnezhad 2020).

While Chmielewski and Kohn in 2000 have demonstrated that high temperatures and dehydration throughout ripe have negatively affected the weight of grain. Generation of wheat in the Mediterranean area is mostly restricted by sub-optimum humidity situations. Khayatnezhad et al., 2020 have represented that signs of herb disposal that are able to see for dehydration in the vegetation condition are leafage wilt and a reduction in the height of herb, herbs number, and leafage space, and lag in the seeding and flower precision. Also, Li et al., in 2000 have demonstrated that the divergence of genes associated with environmental variations has been observed for emmer wheat. Reddy and co-workers in 2004 and Zhao and co-workers in 2008 have shown that comprehension of herb responds for dehydration and also the main section of producing production water deficit have high attention.

Mohammadi et al., in 2010 have demonstrated that the gene sequence corresponding product function in dehydration tensioned and desirable surroundings beseem to be an ordinary beginning step in the description of favorable gene sequence for random rain situations. Betran et al., in 2003 and some investigators have believed in choice under desirable situations, Rathjen in1994 and other ones are believed in a purpose tension situations. While Byrne and co-workers in 1995 and Rajaram and van Ginkel in 2001 still have selected a middle-point and have believed in choice under tension and desirable situations (Khayatnezhad 2012, Khayatnezhad and Gholamin 2012, Khayatnezhad and Gholamin 2020).

In general, various approaches have been suggested for the corresponding dehydration endurance and resisting gene sequence choice, while Fisher and Maurer in 1978 stated that the product of achene in dehydration surrounding can be regarded as a dehydration endurance indicator. And Blum in 1988 suggested which the choice of gene sequence for desiccation endurance should be related to choice for the more production in the non-tension surroundings. Therefore, with estimating of gene sequence product in dehydration and good-watered surroundings, we can choose endurance gene sequence for dehydration. Fernández in 1992 has proved that there can be some choice indices to screen dehydration endurance gene sequence like GMP and STI, Rosielle and Hamblin in 1981 have studied MP and TOL, Jafari and co-workers in 2009 have studied harmonic mean (HM) , Fischer and Maurer in 1978 have worked on stress susceptibility index (SSI), Bet al.,ugh in 1984 have studied yield stability index (YSI), Gavuzzi and co-workers in 1997 have worked on yield index (YI), that recognize sensitive and endurance gene sequence accordance on the productions in non-tension and stress surroundings.

The most suitable choice indicators should identify gene sequence that has consistent perfection in non-tension and tension surrounding. Fernández in 1992 stated that mungbean (*Vigna radiata* L) gene sequence choice according to STI and GMP indicators lead to a gene sequence that has high endurance and product. Clarke and co-workers in 1992 utilized the SSI indicators for identifying among the wheat (*Triticum aestivum* L) gene sequence. In accordance with Sio-Se Mardeh and co-workers in 2006, STI, GMP, and MP were the most suitable indicators under average tension in wheat. The current research's purposes were an assessment of some dehydration endurance indicators also for identifying dehydration endurance gene sequence into the Durum wheat gene sequence.

MATERIAL AND METHODS

The material of herb and empirical arrangement 40 durum wheat reproduction lines (Triticum turgidum var. durum Desf.), were selected for the research in accordance with the important variations in product efficiency under the situation that are watered and non-watered. Investigations have been carried out in the empirical area of Islamic Azad University in Ardabil province, Iran in 2015 till 2018 (3 years of cropping). The empirical design was an accidental whole block plan by 3 irritation. Planting was accomplished by an empirical drill in 1.5 meters × 4 meters layout, including 5 lines 20 cm separate in four hundred grains m2 for every area. Manure was used to 41 kg ha^{-1} N and 46 kg ha^{-1} P_2O_5 and sowing was in accordance with the local soil examination recommendations before planting.

Watering was conducted in the non-tensioned area in the flowering step. For recognizing the physical and chemical features of soil examinations, samples of the soil before ground preparing processes have been conducted. Following the soil laboratory investigation and water laboratory investigation in the Islamic Azad University of Ardebil, samples of 0 till 30 and 30 till 60 cm deepness have been chosen; the outcomes in Table 2 are demonstrated (this examination was conducted solely for soil unity and for avoiding mistakes. in 60 cm wheat root entrance isn't needed for reviewing), and also the outcomes of Rain for 2015 till 2018 years are shown in fig 1 (WWO, 2018).

Dehydration endurance indicators were computed by utilizing the relations that are demonstrated as follows:

Tension severity was (SI=0.2).

Dehydration indicators: Dehydration endurance or sensitivity indicators have been computed for every

Genotype by utilizing the following relations:

1. (STI) = $[Ypi \times Ysi]/(Yp)^2$ (Fernandez, 1992)
2. (GMP) = $\sqrt{(Ypi \times Ysi)}$ (Fernandez, 1992)
3. (TOL) = $Ypi - Ysi$ (Hossain et al., 1990)
4. (MP) = $(Ypi + Ysi)/2$ (Rosielle and Hamblin, 1981).
5. (SSI) = $[1 - (Ysi - Ypi)]/SI$ (Fischer and Maurer, 1978);
6. (YSI) = Ysi/Ypi (Bet al.,ugh, 1984)
7. (YI) = Ysi/Ys (Gavuzzi et al., 1997; Lin et al., 1986)

Which, the cultivar in tension situation product is demonstrated by Ysi, and the cultivar in normal situation product is demonstrated by Ypi, the intensity of stress is demonstrated by (SI), that SI= $1 Ys/Yp$; the whole yield average in stress situation is demonstrated by Ys, the whole yield average in the standard situation is shown by Yp. Through the water deficit indicators, more amount of SSI and TOL present almost extra susceptible for tension, therefore a minimum amount of SSI and TOL are desirable. The choice in accordance with the 2 principles chooses gene sequence by the potentiality of the lower product supporting non-tension situations and large product supporting tension situation. So, Fernandez in 1992 has demonstrated that the choice in accordance with GMP and STI would lead to gene sequences by more water deficit and the potentiality of the product would be chosen.

Statistical analysis: Variance Analysis, average comparing, the relationship among various methods and gene sequence group analysis in accordance with the distance of Euclidean was calculated using SPSS-25 and MSTAT-C softwares (SPSS, 2018). The Principal component analysis (PCA) was utilized for classifying the screen procedures also the gene sequence. According to the PCA, the display of bi-plot was as well as utilized for identifying endurance and large producing gene sequence utilizing Minitab16 software.

RESULTS AND DISCUSSION

Important variations between the gene sequences from the product aspect under non-tension and stress situations have existed (Table 3). Also, important variations between gene sequences have been seen for whole dehydration endurance indicators in the 0.01 possibility stage (Table 3). According to the attained outcomes, there exists a large genetic difference between gene sequences that can be an effective source for the dehydration endurance germplasm choice. The empirical variation coefficient (CV) altered from 3.48 to 23.18. Nonetheless, for a large number of features, the amounts were smaller than six percent (Table 2). Endurance indicators were computed in accordance with the GY of the gene sequences (Table 4). Large product amount in tension and non-tension surroundings was presented by gene sequences 'NO. 40 (4411.22 Kg ha^{-1}) and 'NO.32' (4256.34 Kg ha-1) orderly (Table 4). The highest STI amount (1.07), MP (3642.11) and GMP (3590.85) indicators were with gene sequence 'NO.35'. The max YI amount (1.24) was from gene sequences 'NO.39' and 'NO.21' (Table 4). In the following investigation, regression of generic linear model of GY under dehydration tension on YSI showed a positive association among these criteria by a similar determining ratio (R2= 0.83).

Golabadi and co-workers in 2006 and Talebi and co-workers in 2009 have demonstrated that choice according to a composition of indicators could produce so effective criteria to improve the wheat dehydration endurance however, association ratios are effective for finding the general linear degree correlation among every 2 properties. Therefore, a more desirable method in comparison with an association analysis like a bi-plot is required for identifying better gene sequences for non-tensioned and tensioned surroundings. for identifying the better indicators of choice for dehydration endurance gene sequences, the association ratio among these indicators as well as yield in the normal irrigation situation (YP) also yield in the stress situation (YS) was defined (Table 5).

Table 1. Durum wheat genotypes and regions.

NO.	Genotype	NO.	Genotype
1	Hordeiforme	21	Africanum
2	Africanum	22	Leucurum
3	(Omrabi15)	23	Hordeiforme
4	Leucurum	24	leucumelan
5	Melanopus	25	Niloticum
6	Hordeiforme	26	Africanum
7	Leucurum	27	Boeuffi
8	Leucurum	28	Leucumelan
9	Melanopus	29	Apulicum
10	Leucurum	30	Erythromelan
11	Reichenbachi	31	Barakatly-95
12	Saiymareh	32	Sharq
13	Hordeiforme	33	Hordeiforme (Ahar)
14	Apulicum	34	Apulicum
15	Boeuffi	35	Apulicum
16	Leucumelan	36	Africanum
17	Melanopus	37	Melanopus
18	Albiprovinciale	38	Boeuffi
19	Murceinse	39	Melanopus
20	Leucurum	40	Apulicum

Matrix of association ratios (Table 5) showed thatGMP, MP, STI, YI and TOL indicators can efficiently be utilized to screen of dehydration endurance gene sequences. SSI and TOL under rainy situation were negatively and extremely remarkably (P<0.05) associated with Ys (Table 5). Richards in 2002, Van Ginkel and co-workers in 1998, Rajaram and Van Ginkel in 2001, Betran and co-workers in 2003 determined 2 principal classes of the theory herb growers that aim their germplasm for dehydration-prone regions. The 1-st theories declare which large input receptivity and genetically large producing potentiality, composed by tension-adaptive features would ameliorate efficiency in the dehydration-influenced surrounding.

PCA (principal component analysis) showed that the 1-st PCA revealed 59.3 percent of the whole information variety and possessed positive association with the function under non-tension and tension surroundings (Table 6). Therefore, the 1-st dimension presents the product potentiality and dehydration endurance. We can state that this element could divide the gene sequences by more product under non-tension and tension situations. The 2-nd PCA revealed 39.9 percent of whole information variety (Table 6). The 1-st 2 PCAs considered for approximately 99.2 percent of the whole variety. PCA showed the indicators can distinguish the wheat gene sequences. Bi-plot representation described gene sequences NO‘ 18, 22, 17, 23, 39, 6, 25, 19, 16, 30, 33, 10, 35, 32, 40, 1, 36 and 21’ placed near to significant dehydration endurance indicators which verify the gene sequences being dehydration endurance.

Table 2. Soil analysis outcomes

Soil type	Soil texture			Absorbent Potassium ppm))	Absorbent Phosphorus (ppm)	Total nitrogen (%)	Organic carbon (%)	Neutral-reacting material (%)	(PH)	Electrical conductivity (ds/m)	Saturation	Depth (cm)
	Sand	Silt	Clay									
Clay	40	36	24	290	2	0.056	0.47	7	8.2	2.4	45	.0-60
Clay loam	31	41	28	460	4.8	0.103	0.97	4.8	7.8	2.66	48	0-30

Table 3. The average of seed production of genotypes gene sequence under both conditions

Source of variation	Mean Square									
	df[1]	YP[2]	YS[3]	SSI[4]	TOL[5]	MP[6]	GMP[7]	STI[8]	YI[9]	YSI[10]
Genotypes	39	6427.2**	4462.2**	0.9**	5588.1**	4047.5**	4115.6**	0.103**	0.067**	0.04**
Year	2	8247.0**	1314.1**	1.2*	1097.0**	2291.3**	1810.8**	0.46**	0.003**	0.4**
Error	78	1.42	1.52	0.06	4.17	2.01	2.02	0.002	0.0004	0.001
CV (%)11	-	3.9	4.5	23.1	6.9	3.4	5.5	5.3	5.1	4.5

[1]df: degrees of freedom. [2]YP: Yield of a proposed gene sequence in optimum (potential) situations. [3]YS: Yield of a proposed gene sequence in stress situations. [4]SSI: stress susceptibility index. [5]TOL: tolerance index. [6]MP: mean productivity. [7]GMP: geometric mean productivity. [8]STI: stress tolerance index. [9]YI: yield index. 10 YSI: yield stability index. 11 CV: coefficient of variation. **: significant at 0.05 and 0.01 probability level, respectively.

Gene sequence NO‘ 12, 3, 7, 8, 37, 1, 14, 15, 4, 5, 27, 11, 20, 28, 13, 24, 29 and 26 was approaching to SSI and has large YP (grain product in non-tension situation) amount. Hence, this gene sequence had special versatility to the non-tension surrounding. Gene sequence No. 34, belong to minimum product and maximum dehydration sensitivity area in the bi-plot region. There existed genetic variation amongst gene sequences in accordance with their dehydration endurance. Utilizing significant endurance indicators including MP, GMP, STI, HM, YI and TOL gene sequences UPGMA assortment was conducted and 3 groups were created which matched the bi-plot analysis outcomes. As well as the cluster Dendrogram outcomes verified the main element analysis outcomes.

The product amounts of CV in the non-tension situation were 3.94 and the product in tension situation were 4.51. Regarding computed indicators, the amounts changed between 3.48 and 23.18 (Table 2). generally, CV amount more than twenty percent is supposed to be large; nevertheless, could be probable for ignoring from about large CV amounts while F experiment is important and the aforementioned case is observed in some distributed searches (Takemoto et al. in 1988; Xu et al. in 2000; Aliyu and Awopetu in 2005; Zarei et al. in 2007; Okwuagwu et al. in 2008; Kandiç et al. in 2009; Sabu et al. in 2009). Nevertheless, Aliyu and Awopetu in 2005 have shown that the gene sequences impact was so noticeable on considered cases under 2 regimes of watering. Some test has accomplished by Okwuagwu and co-workers in 2008 that has demonstrated that the opposite CV amounts stated in several investigations as our one may be because of physio-genetic features and adaptability degree of the material of herb, small amount of particular each gene sequence in plant, small amount of iteration each gene sequence and/or unsteady surroundings.

Variety owing to gene sequences was important for whole features in 2 situations (rainy and badly watered). This finding proposed that the measure of variations in gene sequences was adequate for providing some range to select gene sequences for improving dehydration endurance. The average comparison illustrated that G40 possessed the maximum GY amount. Product and product-associated features under water deficit conditions were not dependent on the product and product-associated features under non-tension situations; however, this wasn't the item in min intense tension situations. Since STI, GMP and MP can be able to distinguish cultivars generating a great product in two situations.

Table 4. mean product Durum wheat gene sequence under optimum and tension situations, and computed various dehydration endurance indicators[1].

NO	YP	YS	STI	MP	TOL	GMP	SSI	YSI	YI
1	3768.83	3063.08	0.95	3415.96	705.75	3393.94	0.75	0.82	1.19
2	2942.64	2494.36	0.61	2718.51	448.28	2706.25	0.6	0.85	0.97
3	3046.58	2339.81	0.58	2693.2	706.78	2663.03	0.9	0.78	0.91
4	3302.26	2487.56	0.67	2894.92	814.7	2859.45	0.98	0.76	0.97
5	3211.39	2409.16	0.63	2810.28	802.23	2775.37	0.99	0.76	0.94
6	3707.39	2857.8	0.87	3282.6	849.58	3248.95	0.92	0.78	1.11
7	3052.22	2291.72	0.58	2671.97	760.5	2639.29	1	0.76	0.89
8	3155.38	2436.52	0.63	2795.96	718.86	2765.7	0.88	0.78	0.95
9	2856.83	1668.52	0.39	2262.68	1188.3	2176.71	1.74	0.6	0.65
10	4174.59	3097.8	1.07	3636.2	1076.78	3586.61	1.07	0.75	1.2
11	3449.46	2364.17	0.67	2906.82	1085.29	2847.13	1.28	0.7	0.92
12	3158.78	2356.52	0.62	2757.66	802.26	2723.99	1.04	0.75	0.92
13	3214.58	2142.92	0.56	2678.76	1071.66	2618.26	1.38	0.68	0.83
14	3172.99	2308.52	0.6	2740.76	864.47	2699.68	1.09	0.74	0.9
15	3170.94	2308.04	0.61	2739.5	862.9	2701.17	1.13	0.73	0.9
16	3496.98	2809.8	0.81	3153.4	687.18	3128.07	0.76	0.81	1.09
17	3905.79	3104.2	1	3505	801.58	3476.16	0.81	0.8	1.21
18	3812.19	2643.72	0.83	3227.96	1168.47	3169.12	1.28	0.7	1.03
19	3513.46	2847.08	0.82	3180.27	666.38	3156.22	0.73	0.82	1.11
20	3539.06	2265.8	0.66	2902.43	1273.26	2826.1	1.52	0.65	0.88
21	3864.19	3193.8	1.02	3529	670.39	3507	0.67	0.83	1.24
22	3751.54	3172.52	0.98	3462.04	579.02	3443.6	0.57	0.85	1.23
23	4152.51	2593.96	0.89	3373.24	1558.54	3277.21	1.61	0.63	1.01
24	3240.98	2249.16	0.6	2745.07	991.82	2693.45	1.25	0.7	0.87
25	3796.19	2909.32	0.91	3352.76	886.87	3317.42	0.94	0.77	1.13
26	3422.1	2248.04	0.63	2835.08	1174.06	2767.7	1.44	0.67	0.87
27	3237.79	2402.92	0.64	2820.36	834.86	2782.57	1.03	0.75	0.93
28	3924.19	2233.8	0.72	3079	1690.39	2955.95	1.86	0.57	0.87
29	3156.23	2248.84	0.58	2702.54	907.38	2658.91	1.18	0.72	0.87
30	3351.06	2716.36	0.75	3033.71	634.7	3010.22	0.71	0.82	1.06
31	4032.5	1796.52	0.6	2914.52	2235.98	2687.58	2.43	0.45	0.7
32	4256.34	2846.6	1.01	3551.48	1409.73	3478.18	1.43	0.67	1.11
33	3541.46	2864.04	0.83	3202.75	677.42	3178.3	0.73	0.82	1.11
34	2308.19	2901.32	0.54	2604.76	-593.14	2575.28	-1.52	1.3	1.13
35	4246.1	3038.12	1.07	3642.11	1207.97	3590.85	1.19	0.72	1.18
36	3988.19	2751.56	0.9	3369.88	1236.62	3307.39	1.3	0.7	1.07
37	3101.14	2392.52	0.61	2746.84	708.62	2716.72	0.88	0.78	0.93
38	2924.19	1993.16	0.48	2458.68	931.02	2407.16	1.29	0.69	0.78
39	3912.63	3188.84	1.03	3550.74	723.78	3528.12	0.75	0.82	1.24
40	4411.22	2818.76	1.03	3615	1592.46	3521.65	1.55	0.64	1.1

1 indicators: see Table 3.

While the tension has been intense, TOL, YSI, and SSI have been seemed to be so effective indicators separating endurance cultivars, however, any of indicates cannot definitely recognize cultivars by the large product under non-tension and tension situations (cluster A cultivars). Blum in 1996 has concluded which the choice indicators productiveness relies on the intense of the tension under the opinion which solely supporting average tension situations, potentiality product considerably affects product supporting tension.

The growers that support choice in desirable surroundings obey this theory. Yielders, hence, would rather cultivars which generate large productions while water isn't such restricting, however, Nasir Ud-Din and co-workers in 1992 have found that suffering the smallest damage throughout dehydration seasons. The 2-nd idea is which improvement in product and adoption in dehydration-influenced surroundings could be obtained solely with choice under the prevalent situations discovered in purpose surroundings (Ceccarelli in1987, Ceccarelli and Grando in 1991and Rathjen in 1994). Falconer in1952 has given the theoretic system for this subject that Falconer has written, ''Product in the min and max producing surroundings could be regarded as divide features that aren't certainly enlarged with same allele's collection''.

Table 5. The association among various dehydration endurance indicator 1 and an average production of Durum wheat gene sequence under optimum and tension situations

	YS	YP	GMP	MP	TOL	SSI	STI	YI	YSI
YS	1								
YP	0.495**	1							
GMP	0.88**	0.846**	1						
MP	0.837**	0.890**	0.995**	1					
TOL	-0.363*	0.63**	0.121	0.207	1				
SSI	-0.514*	0.455**	-0.054	0.017	0.947**	1			
STI	0.873**	0.849**	0.998**	0.994**	0.130	-0.043	1		
YI	1.00**	0.495**	0.88**	0.837**	-0.362**	-0.515**	0.873**	1	
YSI	0.252**	-0.444**	0.067	-0.004	-0.945**	-1.00**	0.056	0.525**	1

1 indicator: see Table 3. ** And *: important at 0.01 and 0.05 possibility stages.

Table 6. Eigen amount and main element analysis vectors for potential yield (YP), stress yield (YS) and dehydration endurance indicator[1].

Principal component	1	2
Percentage of variance	59.3	39.9
Cumulative percentage	59.3	99.2
YS	0.41	-0.16
YP	0.32	0.35
GMP	0.42	0.09
MP	0.41	0.13
TOL	-0.02	0.52
SSI	-0.10	0.50
STI	0.42	0.10
YI	0.41	-0.16
YSI	0.10	-0.50

1 Indices: see Table 2.

In general, dehydration tension diminished remarkably the product of several gene sequences and some can be shown endurance for dehydration that in this material, proposed the genetical variations for dehydration endurance. Hence, according to the restricted model and surroundings, examination and determination under tension and non-tension situation solely can't be so efficient for enhancing production under dehydration tension. The positive and important association of Yp and MP, STI and GMP demonstrated that these indicators were so efficient in recognizing large producing cultivars under various precipitation situations. The estimated improve outcomes from the devious choice in precipitation tension surrounding could gain production in precipitation tension surrounding more desirable in comparison with a choice from the non-precipitation tension surrounding. So, wheat growers must consider the surrounding tension intensity while selecting an indicator. Ultimately, we can understand from these studies that gene sequence No. 10 and 35 in accordance with STI, Mp and GMP indicators were endurance gene sequence and these gene sequences are helpful for dehydration endurance choice.

in the time of gathering, for preventing boundary impact, fifty cm of every line from two sides were deleted for gathering and calculating Plot production.

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