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ORIGINAL ARTICLE

Effect of Different Zinc Levels on Seed Filling Rat and Different Agronomic Traits of Sesame *(Sesamum indicum* L.*)* Genotypes

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Ghasem Mohammadi-Nejad, Salehe Bahremand, Pooran Golkar; Effect of different zinc levels on seed filling rated and different agronomic traits of sesame *(Sesamum indicum)* genotypes

ABSTRACT

In order to evaluate the diversity of pheno-morphologic traits, yield, its components and seed filling rates in different sesame genotypes at different zinc rates, an experiment was carried out in split plot design based on randomized complete block design with 3 replications in 2009 at Anbarabad research station of horticultural research Institute, Kerman. Experimental factors were zinc as main factor in three levels (1, 2 and 3 times of spraying with 3/1000 dose) and sesame genotypes (Markazi, Shahrbabak, Shiraz, Dezful, Jiroft, Sirjan, Gorgan, Ardestan and Orzoieh landraces) were considered as sub factors. Results showed that plant height, capsule number/plant, 1000-seed weight and harvest index (%) were significantly different in various levels of zinc, while seed yield, seed number/capsule, number of branch, biological yield, capsule number / plant didn't show significant different in various rates of zinc. The highest mean for plant height and capsule number/plant was obtained from 2 times spraying. The highest amount of 1000-seed weight was belonged to 3 times of zinc spraying. Genotypes showed significant different for all of the studied traits. Interaction effect of zinc ×genotype for plant height, biologic yield, harvest index, yield and its components were significant. Seed yield had significant correlation with plant height, capsule number/plant, seed number/capsule, branch number, biological yield and 1000-seed weight. Modeling of multiple linear regression showed that plant height and number of branches per plant controlled 59% of variation for seed yield. According to logistic model of regression the highest seed filling rates was belonged to Jiroft landrace with 3 times of zinc spraying. Number of branches and plant height were known as the most effective traits on seed yield. Thus, Orzoieh, Shiraz and Jiroft landrces are suggested for cultivation in south east part of Iran.

Key words: filling rate, seed, sesame, yield, zinc.

Introduction

Oil seeds have an important role for people nutrition after cereals [7,1]. Iran is one of the most consumers of nutrition oil. Thus, various studies and evaluations have been carried out to estimate the possibility of cultivation of different oilseeds at different geographical areas of Iran. Zinc is one of the most important micronutrient in plants. It has an important role in enzyme combination, translocation procedure, nucleic acid structure, and protein synthesis and auxin metabolism. Application of zinc in soja caused an increase in dry matter, 1000 seed weight and seed yield [2]. Micronutrients have significant effect on seed yield of rapeseed [4].

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Interaction effect of zinc × genotype has a significant effect on 1000 seed weight, seed yield, seed number/capsule and plant height in sesame. Correlation and regression analyses showed that the variation among genotypes for yield is compromised from differences in seed number/capsule and capsule number /plant [4].

Material and method

This research was carried out at Anbarabad Research Station of Horticultural Research Institute, Kerman, Iran during summer of 2008. In order to detect physical and chemical properties of the experimental field soil, sampling was done from the soil depth of 30cm. Soil analysis showed that there were no salinity and sodicity problems. Also soil texture was sandy loam. The experiment was carried out as a split plot base on randomized complete block design with 3 replication .Totally, there was 27 treatments (3 rates of Zinc sulphates along with 9 genotypes of sesame).

Zinc rates were considered as main factor in with 1, 2 and 3 times of spraying zinc sulphate (with 2.5/1000 dose) and 9 genotypes of sesame including (Markazi, Shahrbabak, Shiraz, Dezful, Jiroft, Sirjan, Gorgan, Ardestan and Orzoieh landraces) as sub factor. Each plot consisted of four rows with 40 cm apart between rows and 4m length. Factors such as yield and yield components (capsule number/plant ,seed number/capsule, capsule diameter, 1000 seed weight, plant height ,number of branches, biological yield and harvest index were evaluated. Yield components were measured on ten randomly samples taken from the middle rows per plot, Seed and biological yield were assessed on the middle row of the plot after removing the border rows. After data collection, different statistical analyzes including ANOVA and correlation coefficient were done by using Microsoft Excel and SAS soft wares.

Results and discussion

Analysis of variance showed significant effects of zinc rates on capsule number/plant, 1000 seed weight, harvest index (Table 1). Also zinc treatments had non significant effect on other traits (Table 1). The highest seed yield was obtained from for Orzoieh landrace (2 times of spraying) along with Jiroft and Shiraz landraces (1 time spraying). Evaluated genotypes showed significant differences, except for plant height, capsule number/plant, seed number/capsule, 1000-seed weight, capsule length and branch number/main stem, biological yield, seed yield, harvest index. The result showed that Jiroft, Orzoieh and Shiraz landraces had the most seed yield among studied genotypes and is known as the most adapted genotype for Jiroft region (Table 2). In this condition 2 times of zinc spraying was the best treatment for Zinc Spraying (Table 2).

Maximum of TDW (dry weight variation) was belonging to Giroft landraces with 2 time of zinc application (data not shown). The highest LAI (Leaf area index) belong to Orzoieh, Shiraz and Jiroft landraces with 2 times of zinc spraying (data not shown). Also the highest CGR (Crop Growth Rate) was denoted to Shiraz landrac with 2 times of zinc spraying (data not shown). Interaction of zinc×genotype was significant for times of zinc application for capsule number/plant, seed number/capsule, biological yield and seed yield (Table 1). According to result of ANOVA, the effect of Zinc on seed yield were not significant and seed yield of different zinc rates grouped in a same group. Sesame genotypes were different in seed yield. Higher seed yield (3473kg/ha) belonged to Orzooieh landrace and the lowest (910/3kg/ha) belonged to Gorgan landrace. Interaction effect of zinc×genotype on seed yield was significant. Higher seed yield obtained for 2 times of Zinc spraying in Orzooieh landrace. Orzooieh landrace is suggested as best genotype for planting at Jiroft.

Means with different letters are statistically different based on Duncan Multiple Range Test.

Correlation Studies and path Coefficient has been studied in sesame [5,6,3]. Correlation coefficient was calculated to study the effect of Zinc spraying on different studied traits. Seed yield had significant and positive correlation with seed number/capsule, number of branch, plant height and harvest index (Table 4). In 2 time spraying, seed yield had positive and significant correlation with plant height, capsule/plant, Seed/capsule, number of branches and 1000-seed weight.

Modeling of Liner Multiple Regression:

In order to gain a predictor model of yield variation and study the traits effective on yield, regression modeling was conducted based on stepwise regression, biological yield and harvest index were considered as the main traits that explained 98% of total variation in yield. Liner model for seed yield is showed:

$\hat{y} = 0.603x_1 + 0.49x_2 + 0.001$, that X_1 is plant height and X_2 is the number of branches per plant.

Logistic model of seed filling rates of different genotypes and different fertilizer levels showed in graphs (Graphs1-13). These graphs showed that changes of seed filling processes in this experiment. Contrast coefficient value in different genotypes and fertilizers is different. According to different graphs of logistic regression model, Jiroft landrace with regression coefficient of 0.72 in compare with other

Table 1: Analysis of variance for different studied traits in sesame genotypes.

S.O.V	df	PH	CP	SC	CL	BN	SW	SY	BY	CN/MS	HI (%)
Replication	2	123.01	175.89	71.93	0.06	2.41	0.38	257747.59	3406079.69	299.68	100
Zinc	2	355.79*	3256.12*	47.06$^{n.s}$	0.02$^{n.s}$	0.37$^{n.s}$	0.8*	737717.28$^{n.s}$	1127904.59$^{n.s}$	292.12$^{n.s}$	400**
Error(a)	4	54.11	281.79	47.03	0.05	0.26	0.08	419253.88	505044.59	110.98	20
Genotypes	8	5851.98**	3677.87**	843.46**	0.52**	33.85**	0.85**	7075249.07**	7740310.39**	3212.21**	1300**
Zinc× genotypes	16	412.82**	2160.26**	100.07*	0.1**	2.32**	0.3$^{n.s}$	685329.94**	2283429.60**	207.24**	200$^{n.s}$
Error(b)	48	75.76	334.51	53.09	0.03	0.36	0.2	258025.92	528940.3	112.46	18
CV (%)		6.34	18.05	10.38	6.39	18.66	13.45	24.32	17.34	21.29	32.32

*and ** significant at P<0.05 and P<0.01 respectively; ns: non-significant.
PH: plant height, CP: capsule per plant, SC: Seed number per capsule, CL: capsule length, BN: number of branches, SW: 1000-seed weight, SY: seed yield, BY: biological yield, CN/MS: capsule number per main stem, HI: harvest index

Table 2: Mean comparisons for different genotypes of sesame for different studied traits.

Genotype	PH	CP	SP	CL	BN	SW	SY	BY	CN/MS	HI (%)
Markazi Landrace	91.44^{e}	90.22^{c-e}	62.77^{b}	2.77^{b}	3.11^{d}	3^{d}	968.6^{d}	3602.8^{c}	34^{c}	28^{ed}
Shahrbabak Landrace	141.37^{e}	90.88^{c-e}	64^{b}	2.5^{c}	0.5^{b}	3.55^{a-c}	1758.9^{bc}	4169^{bc}	86.22^{a}	39^{c-e}
Shiraz Landrace	144^{bc}	101.76^{bc}	83.11^{a}	2.95^{ab}	4.5^{b}	3.77^{a}	3450.3^{a}	3808.9^{c}	40.22^{c}	73^{a}
Dezful Landrace	121.71^{d}	100.62^{cd}	78.44^{a}	3.02^{a}	3.75^{c}	3.66^{ab}	1997.4^{b}	4819.6^{b}	41.44^{bc}	46^{c}
Jiroft Landrace	185.11^{a}	106.28^{bc}	79.55^{a}	3^{a}	5^{b}	3.55^{a-c}	3205.7^{a}	6634.4^{a}	36.11^{c}	42^{cd}
Sirjan Landrace	151.12^{b}	154.5^{a}	65^{b}	2.51^{c}	4.75^{b}	3.22^{b-d}	1891.6^{b}	3866^{c}	51.22^{b}	49^{bc}
GorganLandrace	117.11^{d}	84.37^{de}	53.33^{c}	2.91^{ab}	2^{e}	2.88^{d}	910.3^{d}	3595.1^{c}	41^{bc}	25^{e}
Ardestan Landrace	142.87^{bc}	77.66^{e}	68.77^{b}	2.33^{c}	1^{F}	3.11^{cd}	1340.7^{cd}	3694.2^{c}	77.66^{a}	34^{ed}
Orzooieh Landrace	141^{c}	125.33^{b}	76^{a}	2.77^{a}	6.66^{a}	3.33^{a-d}	3473^{a}	4156.8^{bc}	38.55^{c}	62^{ab}

*and ** significant at P<0.05 and P<0.01 respectively.; ns: non-significant.
PH: plant height, CP: capsule per plant, SC: Seed number per capsule, CL: capsule length, BN: number of branches, SW: 1000-seed weight, SY: seed yield, BY: biological yield, CN/MS: capsule number per main stem, HI: harvest index

Table 3: The effect of zinc treatments on studied traits mean.

Zinc Rates	PH	CP	SP	CL	BN	SW	SY	BY	CN/MS	HI(%)
1time spraying	132.04^{b}	88.95^{b}	68.70^{a}	2.8^{a}	3.07^{a}	3.15^{b}	2070.3^{a}	4007.3^{a}	46.42^{a}	45^{a}
2times spraying	140.92^{a}	112.47^{a}	70.96^{a}	2.75^{a}	3.2^{a}	3.4^{a}	2328.8^{a}	4281.5^{a}	52.77^{a}	40^{a}
3times spraying	138.28^{a}	102.5^{a}	70.88^{a}	2.71^{b}	3.41^{a}	3.48^{a}	1854.9^{a}	4293.8^{a}	50.07^{a}	39^{b}

*and ** significant at P<0.05 and P<0.01 respectively.; ns: non-significant.
PH: plant height, CP: capsule per plant, SC: Seed number per capsule, CL: capsule length, BN: number of branches, SW: 1000-seed weight, SY: seed yield, BY: biological yield, CN/MS: capsule number per main stem, HI: harvest index

Table 4: Correlation coefficient among studied traits for different genotypes of sesame.

	PH	CP	SP	CL	BN	SW	SY	BY	CN/MS	HI(%)
PH	1									
CP	0.28*	1								
SP	0.25*	0.34**	1							
CL	0.46**	0.41**	0.10$^{n.s}$	1						
BN	0.11$^{n.s}$	0.006$^{n.s}$	0.15$^{n.s}$	0.36**	1					
SW	0.35**	0.19$^{n.s}$	0.54**	0.34**	0.4**	1				
SY	0.26*	0.24*	0.14$^{n.s}$	0.35**	0.13$^{n.s}$	0.11$^{n.s}$	1			
BY	0.73**	0.53**	0.35**	0.52**	0.21$^{n.s}$	0.55**	0.29*	1		
CN/MS	-0.00$^{n.s}$	0.36**	0.12$^{n.s}$	0.18$^{n.s}$	0.28*	0.22$^{n.s}$	0.16$^{n.s}$	0.34**	1	
HI	-0.07$^{n.s}$	0.19$^{n.s}$	0.001$^{n.s}$	-0.17$^{n.s}$	-0.47**	0.62**	-0.03$^{n.s}$	-0.15$^{n.s}$	-0.12$^{n.s}$	1

*and ** significant at P<0.05 and P<0.01 respectively.; ns: non-significant.

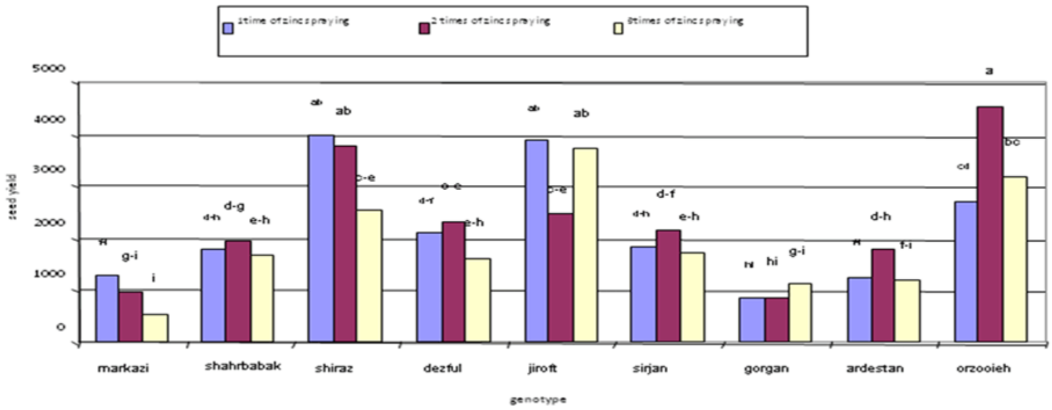


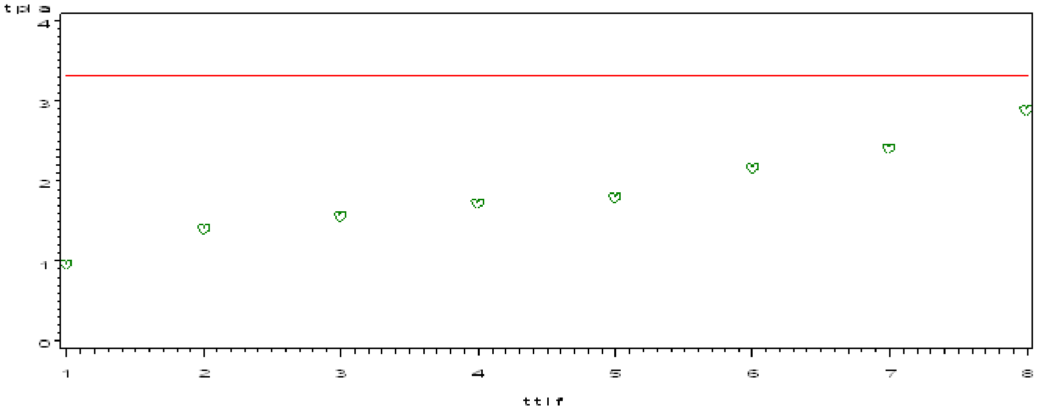
Fig. 1: Interaction effects of zinc × genotype on seed yield.

genotypes had more suitable condition and has saved more dry matter in its seed. Gorgan landrace with regression coefficient of -0.24 had minimum of seed filling rates.

According to this result, genotypes that were able to translate photosynthesized material in more time, had the maximum of seed yield. In grow equation at different fertilizer levels, according to graph 3times Zinc spraying with coefficient (0.74) had maximum of seed filling rates and 1 time of Zinc spraying with coefficient (-0.21) had minimum of seed filling rates. According to general logistic model of seed filling rates coefficient for seed filling rates is -0.21.

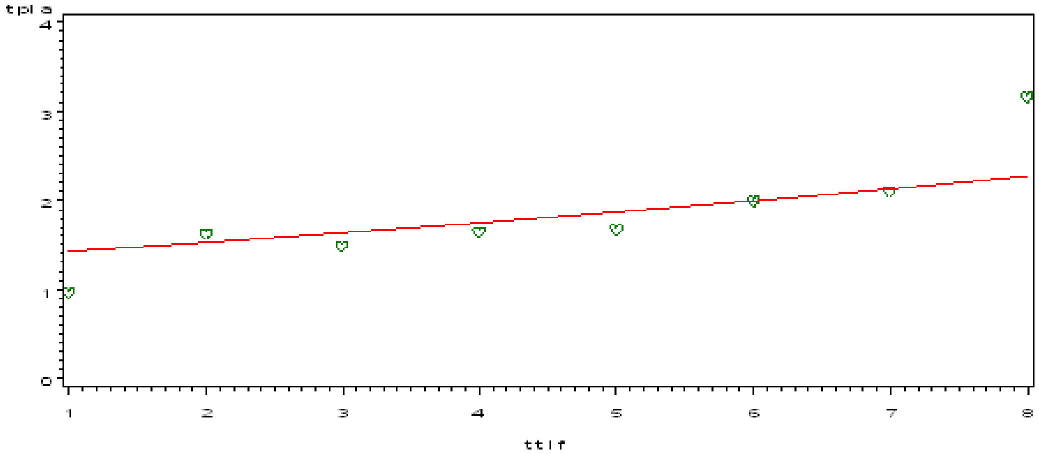
Increasing in fertilizer level from 1 to 3 times of Zinc spraying result to increase seed filling rates and sesame seed can transmission photosynthesis material in more time unit and produce higher seed yield. At least, according to interaction effect of fertilizer ×genotype, Jiroft landrce with high seed filling rate had the most content for seed yield.

General filling seed model of sesame genotypes: $y = \frac{3.31}{1 + e(+0.21(X - 194.5)}$



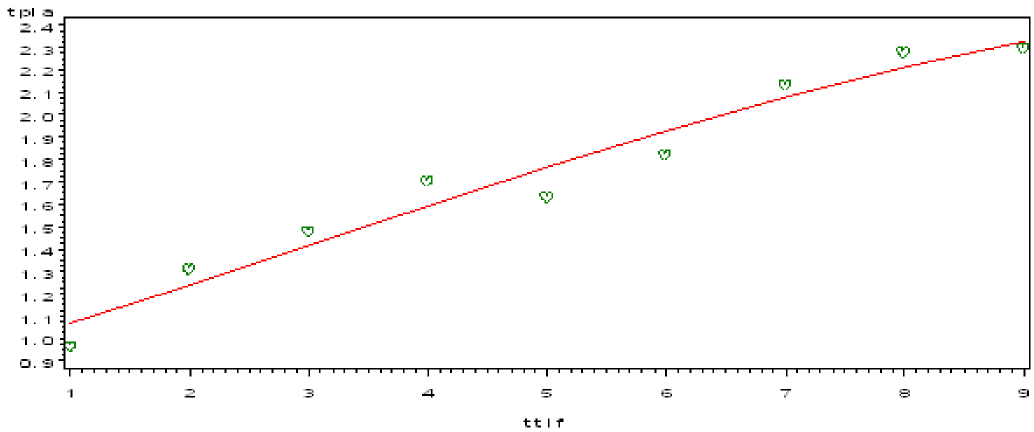
Graph 1: General filling seed processes of sesame genotypes.

Logistic model for Markazi landrace: $y = \frac{64.13}{1 + e(-0.06(X - 56.12)}$



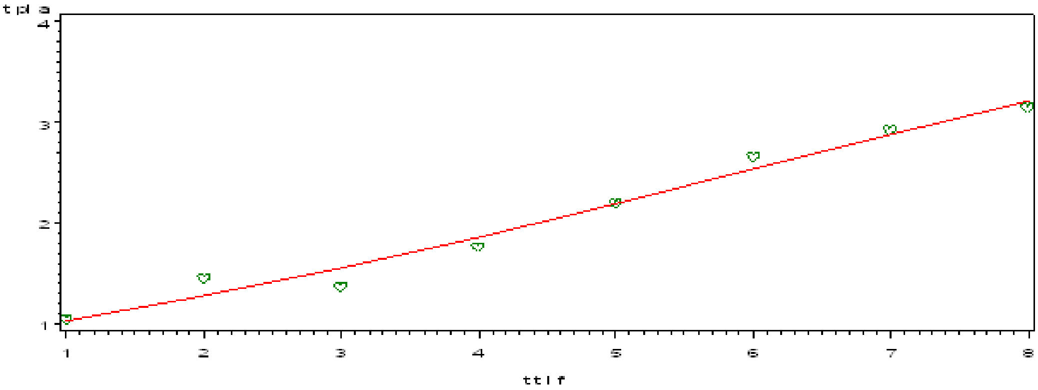
Graph 2: Seed filling process of Markazi landrace.

Logistic model for Shahrbabak landrace: $y = \frac{2.85}{1 + e(-0.25(x - 3.05)}$



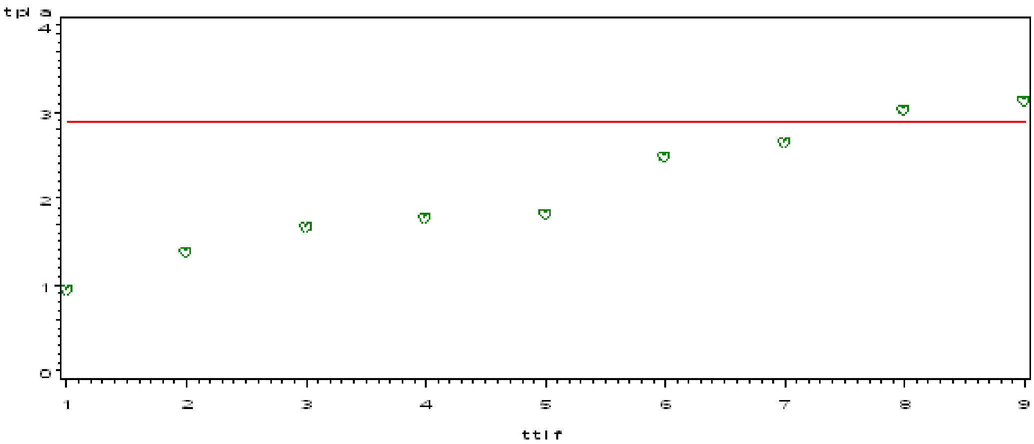
Graph 3: Seed filling process of Shahrbabak landrace.

Logistic model for Shiraz landrace: $y = \frac{5.06}{1+e(-0.27(x+5.98)}$



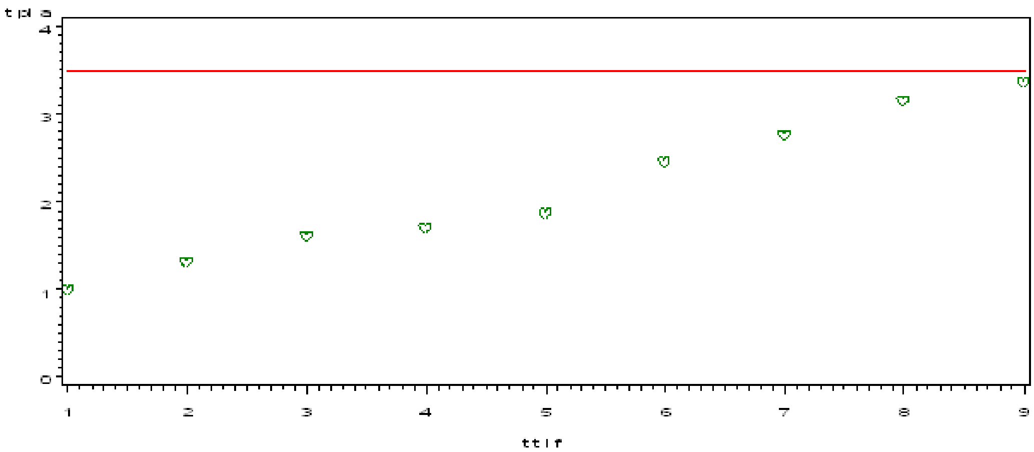
Graph 4: Seed filling process of Shiraz landrace.

Logistic model for Dezful landrace: $y = \frac{2.86}{1+e(-0.53(x+39.10)}$



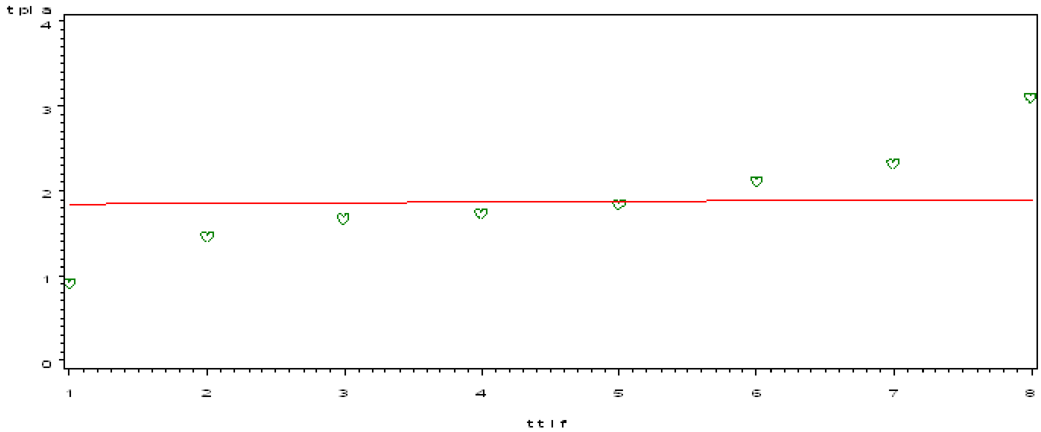
Graph 5: Seed filling process of Dezful landrace.

Logistic model for Jiroft landrace: $y = \frac{3.49}{1+e(-0.72(x+30.34)}$



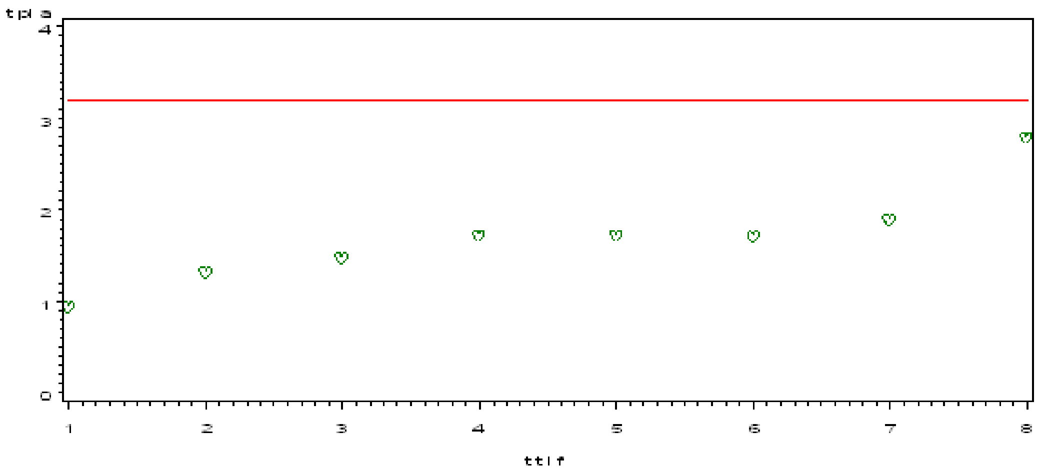
Graph 6: Seed filling process of Jiroft landrace.

Logistic model for Sirjan landrace: $y = \dfrac{8.17}{1 + e(-0.005(x + 220.9)}$



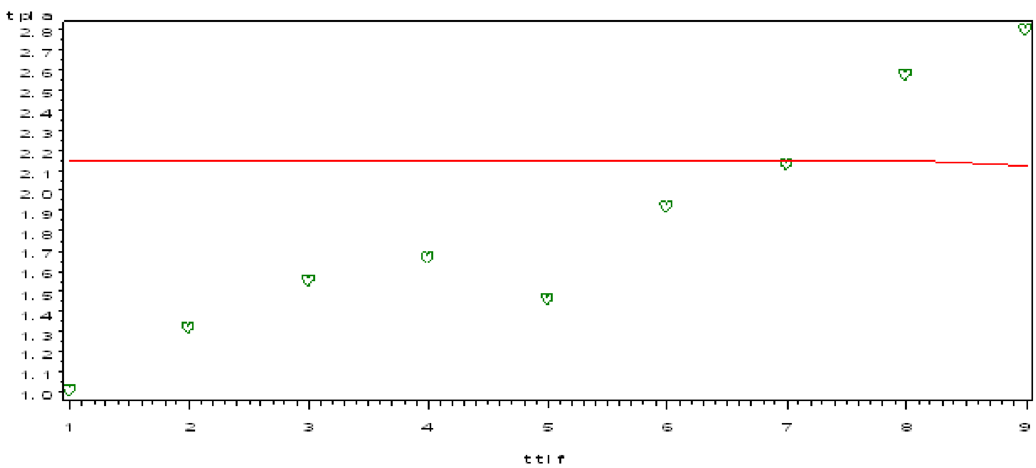
Graph 7: Seed filling process of Sirjan landrace.

Logistic model for Gorgan landrace: $y = \dfrac{3.19}{1 + e(+0.24(x - 495.9)}$



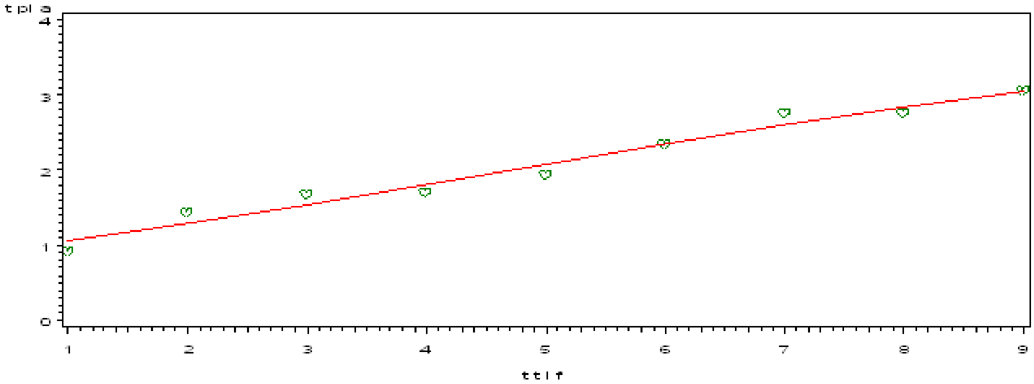
Graph 8: Seed filling process of Gorgan landrace.

Logistic model for Ardestan landrace: $y = \dfrac{2.15}{1 + e(+7.99(x - 9.55)}$



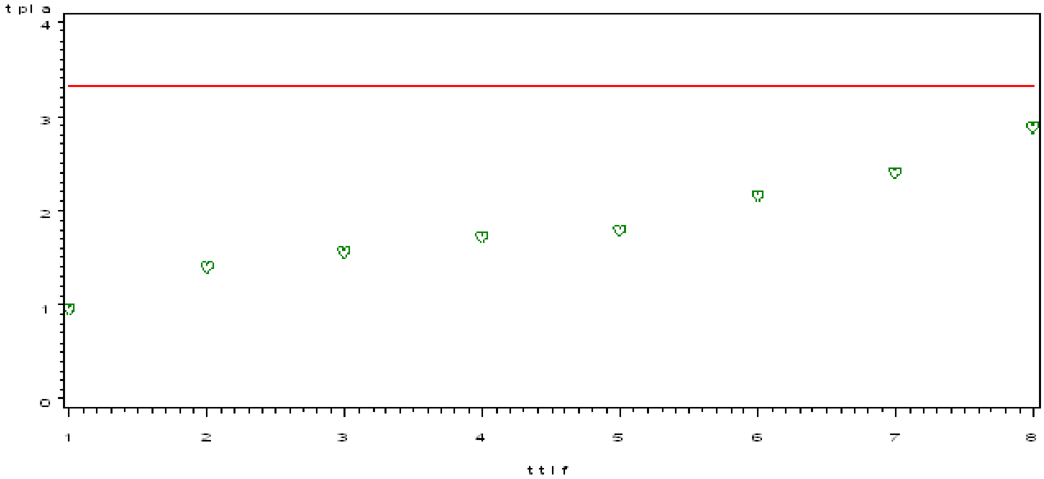
Graph 9: Seed filling process of Ardestan landrace.

Logistic model for Orzooieh landrace: $y = \dfrac{3.99}{1 + e(-0.27(X - 4.71)}$



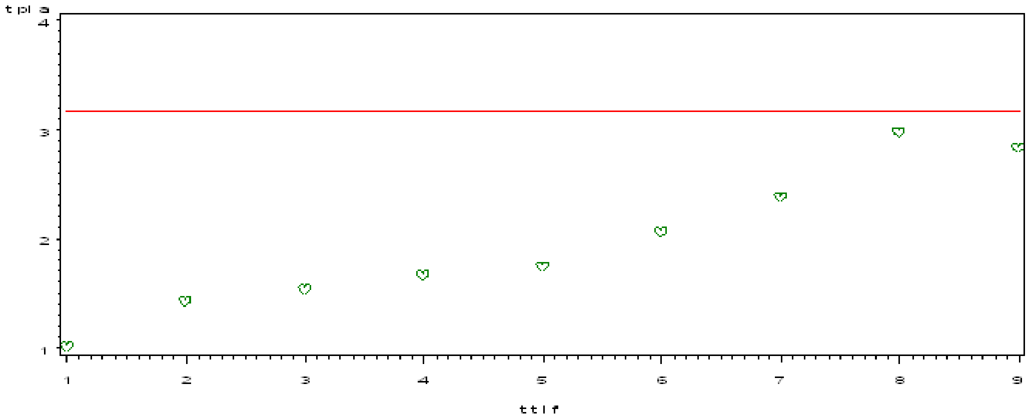
Graph 10: Seed filling process of Orzooieh landrace.

Logistic model for 1time of Zinc spraying : $y = \dfrac{1}{1 + e(+0.21(x - 194.5)}$



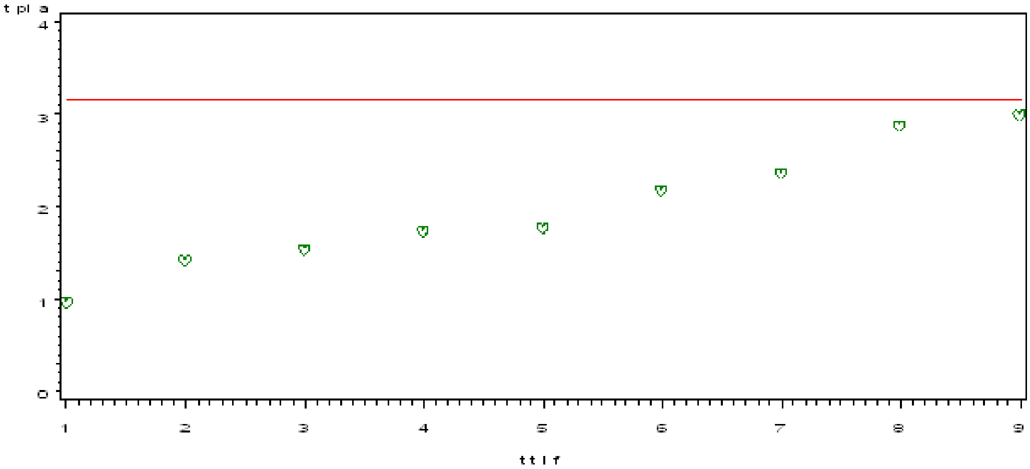
Graph 11: Seed filling process in 1 time Zinc spraying.

Logistic model for 2times of Zinc spraying: $y = \dfrac{1}{1 + e(-0.24(x - 5.71)}$



Graph 12: Seed filling process in 2times Zinc spraying.

Logistic model for 3times of Zinc spraying: $y = \frac{3.15}{1 + e(-0.74(X - 32.03)}$



Graph 13: Seed filling process in 1 time Zinc spraying.

Conclusion:

In this study Zinc application was affected on seed yield of genotypes. Jiroft landrace was known as the most adapted and highest seed yield among evaluated genotypes. The treatment of 2 times of Zinc spraying was the effective ones on seed yield of Orzooieh landrace but treatment of 1 times of Zinc spraying was the best for Jiroft and shiraz landraces. According to these results we could not suggest a time of zinc spraying for all genotypes. This result could be compromised because of different genetic potential of each genotypes to reach to a maximum of seed yield in different zinc rates.

Generally, 2 times of zinc spraying treatment was the best zinc rate for sesame. Biological yield and harvest index controlled the most variation of seed yield among evaluated genotypes. The result of logistic regression showed that the most seed filling rate reached from 3 times of Zinc spraying at Jiroft landrace. We could suggest that by focusing on these traits, it increase seed yield and reach to the highest of its content.

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