Agriculture, Environment & Society (2023) Volume 3, Issue 2, P. 77-92

Agriculture, Environment & Society

Journal homepage: www.aes.uoz.ac.ir

The effects of planting date on quantitative and qualitative yield of sunflower in Iran and the world: A meta–analysis

Mohsen Rezaei [*a], Mohammad Nabi Ilkaee [b], Saeed Souphizadeh [c], Faiyaz Aghayari [b], Abdolmajid Mahdavi Damghani [c]

[a] Department of Agronomy, Fasa Branch, Islamic Azad University, Fasa, Iran
[b] Department of Agronomy, Karaj Branch, Islamic Azad University, Karaj, Iran
[C] Department of Environmental of Sciences, Shahid Beheshti University, Tehran, Iran

ARTICLE INFO

Article history:
Received: 09 March 2023
Accepted: 20 June 2023
Available online: 28 June 2023

Keywords:
Gain oil percentage
Meta-analysis
Planting date
Seed yield
Sunflower

ABSTRACT

The science of meta-analysis provides a comprehensive summary of a set of researches whose results are more stable. Meta-analysis study of the planting date effects on sunflower grain yield quality and quantity were very important in obtaining of perdition results and improving of the economical yield. In this study, using meta-analysis, we want to investigate the effects of planting date on grain yield (GY), number of seeds per head (NS/H) and head diameter (HD) using 40 articles published in Iran and the world (between 1995 and 2018). According to the results, the correlation coefficient except for GY (R=0.2462), NS/H (R=0.2462) was not significant for HD trait. According to the table of average traits, the highest amount of GY (5173 kg. ha^{-1}), NS/H (1818.35), HD (23.9 cm) was in basis of Julian days (JD) with planting date 1-170 JD range. The highest GY in the range of sowing date 80-170 JD, the highest NS/H under 1-80 JD, the highest HD in 17-180 JD, the highest of grain oil percentage (GOP) (52.16%) in 171-262 JD and the highest 1000-seed weight (TSW) (82.11 g) was observed in the treatment of 177-387 JD. According to the results of regression, except for TGW and GOP, other traits showed a negative slope by changing the planting date. Correlation coefficient was significant for GY (R=0.2462) and NS/H (R=0.364). Based on the intensity model of the effect of sowing date on NS/H, GY and TSW under 1-80 JD, the SOP in the range of 176-387 JD and HD in the range of 81-1701 JD were significant. According to the results of bias in the experiment based on funnel diagram, due to the large range of planting date, positive and negative effects of planting date on traits were observed. Based on the accumulation diagram and review of each study, the general results of meta-analysis show it based on the accumulation diagram and review of each study, the general results of meta-analysis show that the best spring planting time identified under mid-May to mid-June (80-170 JD) and under subtropical to tropical regions from mid-February to mid-march (1-80 JD). In these 25 studies, considering the results of meta–regression no negative correlation was seen in the traits of the NS/H and GY. But for other traits no correlation was seen. On the other hand, the results of the accumulation chart also showed that the minimum and the maximum effect size were related to the studies that in addition to the cultivation date had studied the cultivar and cultivation methods including density. So, it is recommended that meta-analysis be done on the other factors.

Highlights

- Meta-analysis provides a comprehensive summary of research results, offering more stable conclusions.
- Highest GY (5173 kg/ha), NS/H (1818.35), and HD (23.9 cm) were observed with planting dates in the range of 1-170 Julian days (JD).
- Correlation Coefficients was significant for GY (R=0.2462) and NS/H (R=0.364), but not for HD.
- Temperature is a crucial factor affecting growth stages and yield.

[*] Corresponding author.
E-mail address: mohagro@gmail.com
https://doi.org/10.22034/jelsa.2024.460430.1070

- Early Planting are beneficial for GY, TGW, and GN/H, especially in saline soils.
- Delayed Planting can reduce yield due to high temperatures during the growing season, affecting traits like HD and PH.

1. Introduction

Sunflower is one of the most important oilseeds that have a strategical role in oil supplying in the country. Sunflower is cultivated in a wide range of months of the year and due to the difference in cultivar characteristics compared to the planting date in order to adapt the important physiological stages of growth, it is necessary to study the effect of planting date on important traits (De lavega et al., 2002).

Climate differences have different effects on plant growth and development, in other words, it regulates the temperature and humidity of plant growth and development stages. Geographical and morphological diversity with the habit of diverse growth in tolerance to high and low temperatures is a sign of optimal adaptation of the sunflower plant (Khalifa et al., 2000). Every year, many studies are conducted on the effects of different planting dates on the quantitative and qualitative traits of sunflower oil. Existence of different soil, climate and crop management conditions often do not show the same GY and biomass (B). For example, sometimes planting date delays have negative and positive effects on GY. Therefore, most researchers are looking for valid results based on scientific principles to adjust their management plans to achieve the desired performance. Since planting date is one of the most important factors in yield production and the results of research on different planting dates in Iran and over the world on the characteristics of sunflower oil are contradictory, so a comprehensive study that can provide reliable results with more data to reach a final conclusion, seems necessary. The purpose of this study is to summarize the effects of planting date and in fact different temperature changes in important phenological stages of plant growth using meta-analysis of yield and yield components of sunflower seeds and oil in Iran and the world.

2. Materials and Methods

2.1. Search Strategy

Data were obtained from long-term studies (1972-2019) on yield and yield component and percentage of oil in grain sunflower in Iran and some other countries were obtained from refereed journals and peer-reviewed conference proceedings through online searches. Our search was comprehensive including the following keywords: sunflower, date of planting, grain yield, meta-analysis, and percentage of grain oil. And our combinations: date of planting (0-80, 81-170,171-262,263-387 in basis Julian day (JD) range. We collected information on date of planting, altitude, location of experiment, agronomic management as reported by the primary authors.

2.2. Data Preparation and Descriptive Statistics

Data required for the meta-analysis were in the form of treatment mean (X), its standard deviation (SD) and the number of replicates (n) mentioned in the experimental design. Several authors presented statistical data in different formats such as standard error (SE) and coefficient of variation (CV %). These forms were converted to standard deviation (SD) using the Eq. 1.

SD= ¼ SE (1)

To overcome these challenges, our searches were carried out online in order to get results from some of the world. We identified the factors in our analysis such the 1000-grain weight (TGW), the number of grain per head (NG/H), the grain oil percentage (SOP), the height of the plants (HP), head diameter (HD), and the grain yield (GY) input which could affect the effect sizes and employed the random effects model. In this research different agricultural studies published in authentic academic journals, information and quotation databases of Islamic world, Jahad Daneshgahi, and mag Iran have been used, as well as conferences, scientific reply of research centers, thesis, and articles presented on Google Scholar, CABI and Scopus. After compiling articles, the ones which could be used in meta-analysis were separated and encoded 26 articles were chosen among 40 articles under study, and processed by meta-analysis. These groups were included in. (0-80, 81-170, 171-262, 263-387 JD range). Then the following important parameters were extracted separately from articles: By using meta-analysis, the data gathered was analyzed and the graphs were drawn. The complete description of the statistical calculation method of meta-analyses is introduced by Hedges et al., 1999. The first step of the meta-analysis is the calculation of average standard deviation of control treatment and experimental treatments under planting date scenarios (Eq. 2).

$$d = \frac{\overline{X}_t - \overline{X}_c}{S_P} \times J \qquad (2)$$

Therefore, for every 36 independent experiment which are surveyed in this meta-analysis an amount of (d) according to Eq. 1 calculated. It must be mentioned that the effects of the planting date were calculated separately (Hedges et al., 1999).

In which X_u and X_t are the averages of control treatments and planting date consecutively, Sp is combined standard deviation of averages, and J is the correction coefficient for the declination of the averages' criterion. The amounts of J and Sp were calculated from Eqs. 2 and 3 consecutively.

$$S_p = \sqrt{\frac{df_c(S_c{}^2) + df_t(S_t{}^2)}{df_c + df_t}} \qquad (3)$$

In which Sc and St are average standard deviation of the treatment a planting date d treatment, df_c and df_t are the degree of voluntary control and planting date. If the amounts of the standard deviation of the averages are not mentioned in the articles, we can calculate the amount of Sp according to mean squared error (MSE) which is present in the tables of variance analysis of articles (Eq. 4) (Hedges et al., 1999).

$$S_p = \sqrt{\left(\frac{n_c + n_t - 2}{n_c + n_t}\right) MSE} \quad (4)$$

In which n_c and n_t are the number of repetitions of control and treatment (Hedges et al., 1999).

No doubt all the experiments do not enjoy the same degree of precision. Therefore, it is necessary to measure the precision of each experiment and then synchronize them according to the effect size. To do this the variance of the effect size for each experiment (V_d) was calculated (Eq. 5).

$$V_d = \left[\frac{n_c + n_t}{n_c \times n_t}\right] + \left[\frac{d^2}{2n(n_c + n_t)}\right] \quad (5)$$

The opposite of this variance is the weight related to that experiment, so each experiment which has a smaller variance, will be heavier (Hedges et al., 1999).

Finally, a total effect size (d) is calculated which it is in fact the standardized variation between control and planting date treatments for all the experiments surveyed (Eq. 6).

$$d^* = \frac{\sum w_i d_i}{\sum w_i} \quad (6)$$

Standard deviation is calculated by Eq. 7 Hedges et al., 1999).

$$S_{d*} = \sqrt{\frac{1}{\sum w_i}} \quad (7)$$

The last stage of meta-analysis is meaningfulness experience of d. If you know S_d you can calculate confidence interval of d. If this confidence interval overlaps zero, then the size of the synchronized cumulative effect (d)

Will not be meaningful and is different from control treatment, otherwise the difference between treatment and control will be significantly more than zero. All the calculations and drawing of graphs was done by excel. Meta-analysis allows quantitative analyses of experimental results reported by other authors and the estimation of effect sizes (Borenstein et al., 2009). The analysis increases the statistical power available to test hypotheses and differences in response between treatments under different environments (Borenstein et al., 2009). The effect size found in each individual study can be considered an independent estimate of the underlying true effect size, subject to random variation. All studies contribute to the overall estimate of the treatment effect whether the result of each study is statistically significant or not. Data from studies with more precise measurements are given more weight, so they have a greater influence on the overall estimate. However, meta-analysis has potential weaknesses due to publication bias and other biases that may be introduced in the process of locating, selecting and combining studies. Publication bias is the tendency on the part of investigators, reviewers and editors to submit or caccept manuscripts for publication based on the direction or strength of the study findings.

2.3. Meta-analysis

There are several metrics that have been thoroughly examined for use in meta-analysis. We chose the two methods that are most widely used in ecology: Hedges'd, a standardized difference-based method, and the log response ratio, ln R, a transformed ratio-based method (Eq. 1) estimates the standardized mean difference in a manner similar to original effect size measurement, and is the most widely accepted measure of effect size used in the social sciences (Hedges and Olkin, 1985). d = [(Ye – Yc)/s] J(m) where Ye and Yc are the means of the treatment (e) and control (c) groups, s is the pooled standard deviation, and J(m) is a correction factor to remove small sample bias.

The difference between the mean of the treatment group (Ye) and the mean of the control group (Yc) is divided by the pooled standard deviation s, providing effect size, a dimensionless statistic. The variance of Hedges'd permits the calculation of confidence intervals around the effect size. Equation 2 is the variance of Hedges'd, Variance of d=s2 (d) = [(n_c + n_e)/n_c n_e] + d2/2(n_c + n_e) (2) where n_c and n_e are the total number of samples (Σnij) in the control and treatment group, respectively (Hedges and Olkin, 1985). Equations 3 and 4 are for the pooled standard deviation and correction factor, respectively: s = [(n_e – 1) (se) 2 + (n_c – 1) (sc) 2]/ (n_e + n_c – 2) where se and sc are the standard deviations of the individual samples, and J (m) = 1 – (3/ (4m – 1) where m ≈ n_c + n_e – 2 .There are potential problems with Hedges' d pointed out that d is sensitive to the differences in sample standard deviations, rather than the actual strength of the process. For example, in two studies measuring the effect of different predators on the same prey, one predator may appear to have a larger effect size, but in reality, d is larger because the studies compiled for that predator had smaller s values than studies compiled for the other. Log response ratio although no single metric of effect size is optimal for all cases, the use of the log response ratio and its variance (Eqs. 5 and 6) is currently favored in the meta-analyses of ecological data (Hedges et al., 1999). InR = In (Ye/Yc) Variance of In R = [(se) 2/n_e (Ye) 2] + [(sc) 2/n_c (Yc) 2] where the notation is consistent with that used for Hedges'd. The log response ratio estimates the proportional change between the treatment and control groups (Rosenberg et al., 2000), thus allowing the fuel reduction effect to be derived from the back-transformed log response ratio. Hedges et al. (1999) presented the statistical properties of the log response ratio and exemplified its appropriate usage in meta-analysis. The log response ratio can only be used for data that can be expressed as a ratio, and where the denominator (mean of the control) is not zero or opposite of the overall effect. CMA version 3.0 software was used to draw the funnel diagram and bias.

2.4. Statistical Analysis

In the first step of the analysis, the test of homogeneity as the amount of p-value in different characteristics was more than 5 % null hypothesis is not rejected (Table 1).

Since the study surveys are different, there will definitely be differences in experiments, there for statistical measurement is not a reason for the heterogeneity of studies, as a result, according to the studied data, assortment was done (Tables 2-5). In the second step the between-studies variance was calculated the between-group homogeneity analysis was conducted. Planting of date was considered as a categorical variable and was coded in four levels JD range (1–80, 81–170, 171-262, 262-387) the results of the assortment showed that the dispersion of the coefficient of changes in some traits of the TGW, NG/H, GOP, HD and PH was high (Tables 2-5), therefore to continuation of meta–analysis seems necessary.

Table 1. Homogeneity analysis

Traits	Df	d	p-valve
Grain yield (kg. ha^{-1})	25	-1.52	0.3749
Plant height (cm)	19	-0.53	0.4652
Number of seed per head	18	-0.75	0.4457
Grain oil (%)	22	0.07	0.4947
Head diameter (cm)	22	-0.25	0.4861
1000-grain weight (g)	21	-0.41	0.4695

Table 2. Mean trails of sunflower and homogeneity analysis (1-80 after Julian Days)

Traits	Planting date (max)	Planting date (min)	cv (%)	Means of control	Means of treatment	df	d	p-valve
Grain yield (kg.ha^{-1})	4882.58	316.2	3.7	2811.872	3109.016	5	3.42	0.0162
Plant height (cm)	210.33	137.6	2.2	173.95	163.85	2	1.61	0.1712
Number of grain per head	1818.25	940.9	19.2	1422.1452	1380.32	4	1.26	0.2026
Grain oil (%)	49.57	29.9	29.1	40.51	38.47	4	-1.62	0.1470
Head diameter (cm)	18.93	10.6	16.07	14.91	16.91	4	2.3	0.1418
1000-grain weight (g)	60.96	41.93	1.39	48.56	53.79	4	2.28	0.0957*

Table 3. Mean traits and homogeneity analysis (81-170 after Julian Days)

Traits	Planting date (max)	Planting date (min)	cv %	Means of control	Means of treatment	df	d	p-valve
Grain yield (kg.ha^{-1})	5173	811.1	6.68	2964.3536	2426.1655	9	-2.86	0.0804*
Plant height (cm)	205.5	123.1	27.4	167.501	154.428	7	-1.27	0.3324
Number of grain/heads	1773	4.4	22.6	1017.07	901.99	7	-1.15	0.3369
Grain oil (%)	48.3	25.8	4.48	41.28	39.75	9	-1.08	0.3326
Head diameter (cm)	23.9	9.73	4.39	15.215	12.865	2	-2.96	0.0725*
1000-grain weight (g)	76.84	19.34	2.75	54.047	50.502	7	-0.52	0.4192

Table 4. Mean traits and homogeneity analysis (171-262 JD range)

Traits	Planting date (max)	Planting date (min)	cv %)	Means of control	Means of treatment	df	d	p-valve
Grain yield (kg.ha^{-1})	4414.3	216.05	11.38	2735.1758	2113.46	12	-1.48	0.3044
Plant height (cm)	166.7	112.5	17.51	147.126	135.43	8	-0.65	0.4244
Grain number/head	12.1	337.8	7.8	892.85	813.37	9	-0.99	0.3807
Grain oil (%)	52.16	21.1	14.8	40.054	40.1	3	1.46	0.1771
Head diameter (cm)	20.73	4.92	7.84	14.99	15.23	13	-0.03	0.4974
1000-Grain weight (g)	76	36	33.13	57.85	54.1	10	-0.28	0.4531

Table 5. Mean traits and homogeneity analysis (263-387JD)

Traits	Planting date (max)	Planting date (min)	cv (%)	Means of control	Means of treatment	Df	d	p-valve
Grain yield (kg.ha^{-1})	2500	.403.2	3	1946.16	2056.81	6	0.02	0.4964
Plant height (cm)	184.1	117.1	2.56	163.67	161.19	7	0.02	0.49692
Grain number/head	935	565.6	0.95	750.3	746.19	2	-0.22	0.4545
Grain oil (%)	51	32	1.97	40.29	42.41	5	0.59	0.3930
Head diameter (cm)	18.4	10.8	6.57	15.42	14.28	5	-0.3	0.45
1000-Grain weight (g)	82.11	31	6.54	62.10	53.24	4	-0.5	0.4135

3. Results

3.1. Sizes Effect

There was no change in weighted mean differences in plant height (PH), therefore planting date had no positive effect on PH compared with control (Figure 1). The results of the intensity of the effect of PH showed that this trait was not affected by planting dates and was not significant in any of the planting dates (Figure 1). In the intensity chart, the effect of number of seeds per head (NS/H) was significantly affected by the range of planting date 1-80 JD range. The intensity of the effect of this trait in the range of planting date 80-170 JD, despite the observed changes, but was not statistically significant (Figure 2). According to the intensity chart, the diameter of the head (HD) was significantly affected by the range of planting date 170-181 JD. (Figure 3). The intensity of grain yield was significantly affected by the range of planting date 1-80 days JD (Figure 4) in the graph, the intensity of the effect of 1000-grain weight (TGW) was significant under the influence of the range of planting date 1-80 JD. But in other domains of planting date, no significant increase was observed (Figure 5). The intensity of the effect was significant in the range of sowing date 263-387 on the percentage of grain oil (GOP) (Figure 6).

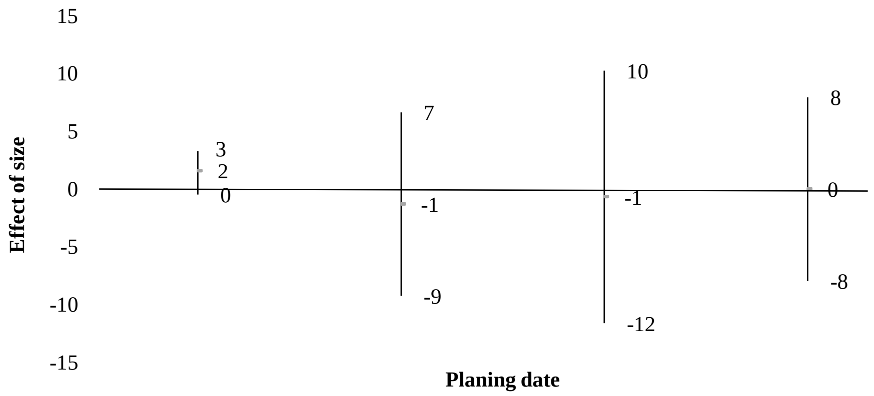

Figure 1. Comparison of different planting dates on PH. Error bars represent 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect

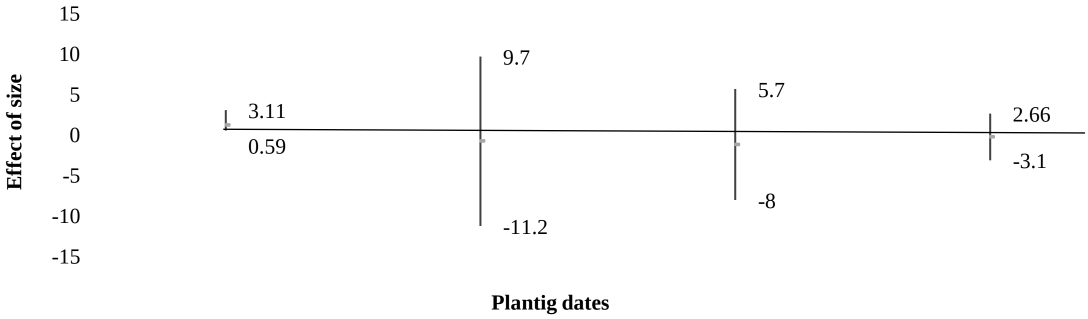

Figure 2. Comparison of different planting dates on GN/H. Error bars represents 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect

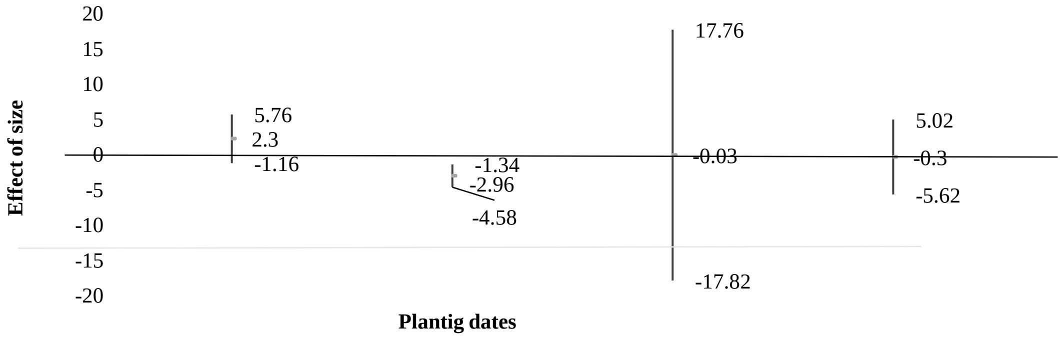

Figure 3. Comparison of different planting dates on HD. Error bars represent 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect

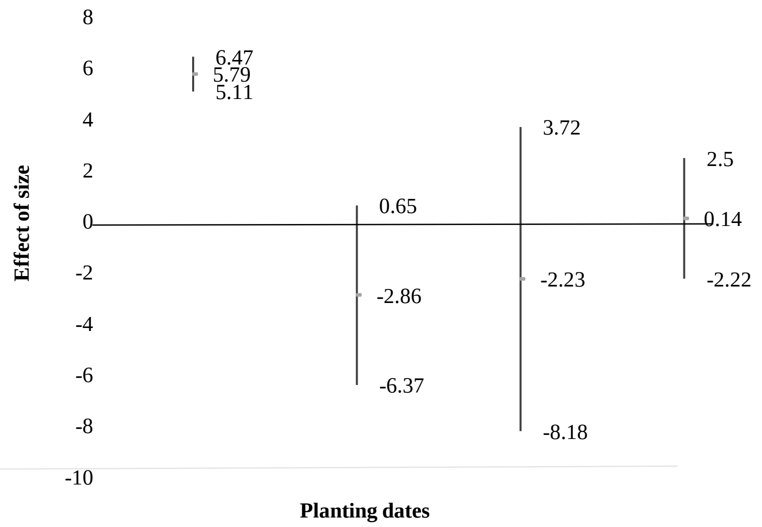

Figure 4. Comparison of different planting dates on GY. Error bars represent 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect

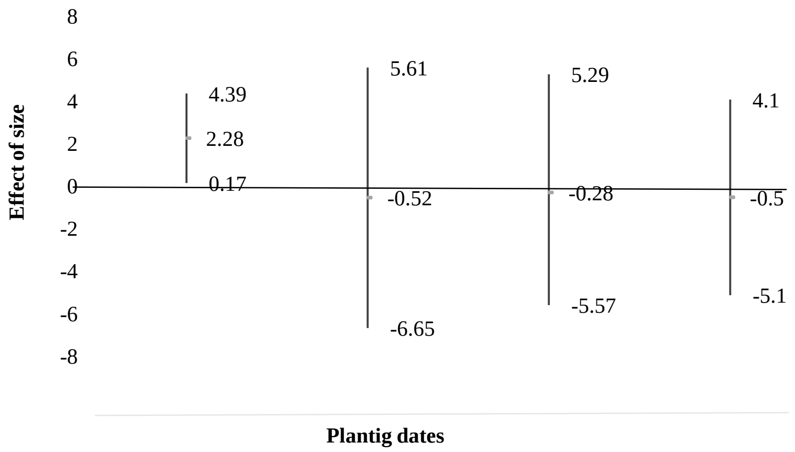

Figure 5. Comparison of different planting dates on TGW. Error bars represent 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect

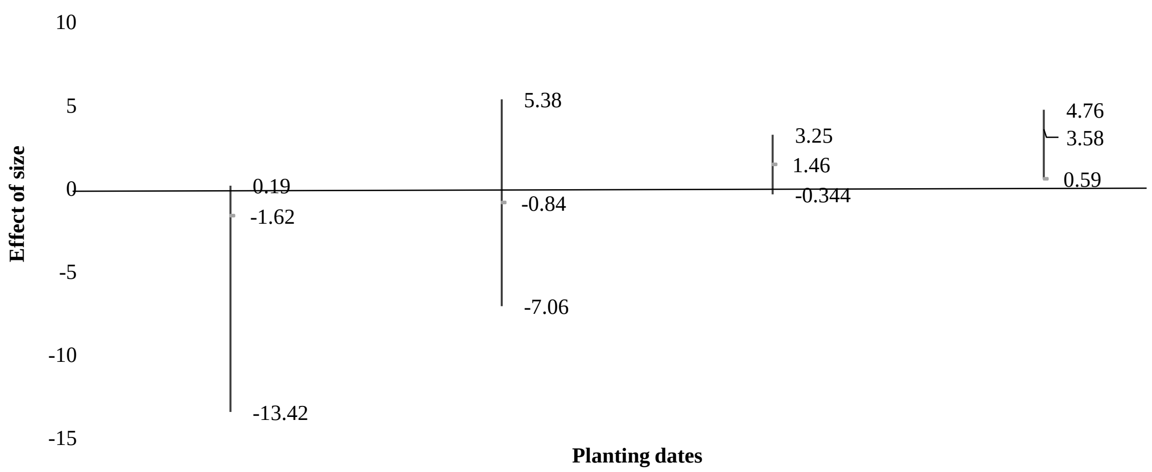

Figure 6. Comparison of different planting dates on GOP. Error bars represent 95% confidence intervals. Vertical lines are the confidence interval size of weighted cumulative effect.

3.2. Meta-regression

Correlation coefficient was not significant, except for GY (R=0.2462) (Figure 7) and NG/H (R=0.364) (8) among other traits, so mentioning these coefficients in the diagrams has been avoided. According to the regression diagram of TGW trait (Figure 9). By changing the planting date, an increasing trend can be seen in this trait. In the regression diagram, the trend of changes in GOP trait under the influence of planting date was fixed (Figure 10). From the meta-analysis presented in Figures 3, 4, 5 and 6, it seems that the response to important economic traits of sunflower oil relate to the range of changes in planting dates is different. Giving the process of trait changes except for TGW and GOP, other traits had a negative slope under the influence of planting date, which shows the negative effect of planting date on these traits (Figures 7-12).

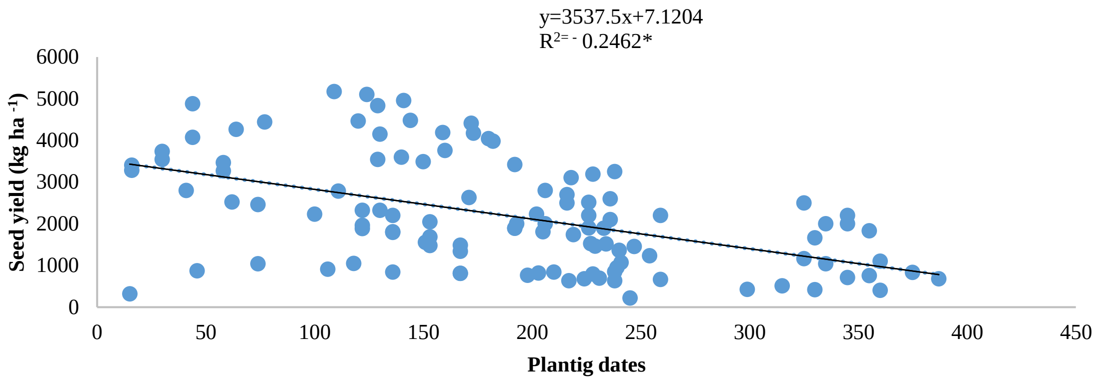

Figure 7. Response of GY to planting dates (p-value= 0.3749, N = 110)

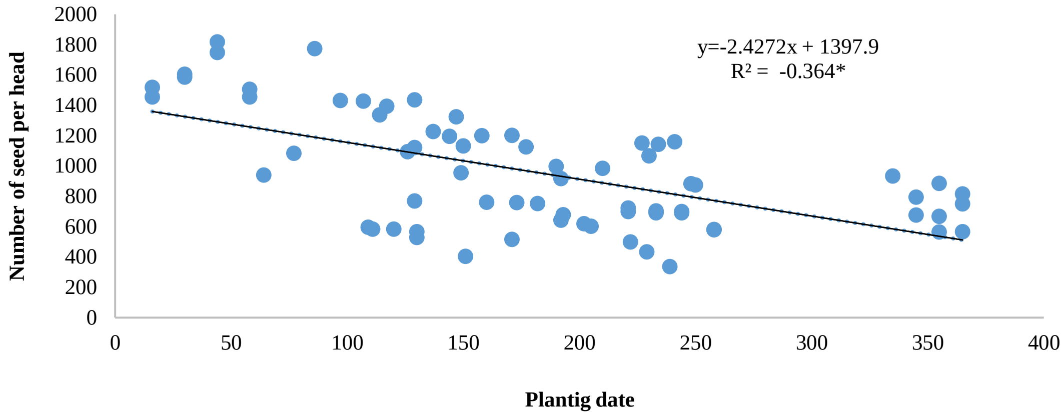

Figure 8. Response of NG/H to planting dates (p-value=0.4457, N =70)

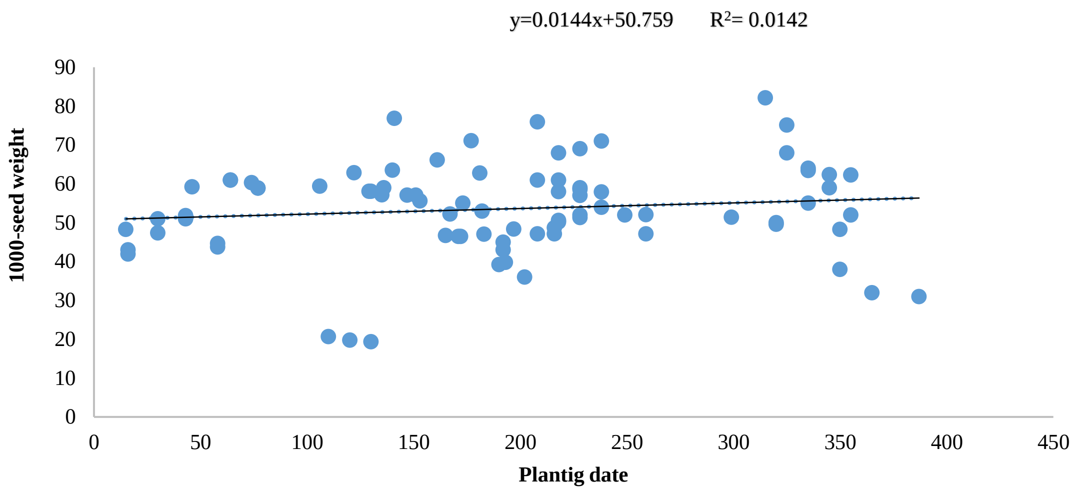

Figure 9. Response of TGW to planting dates (p-value=0.4695, N =84

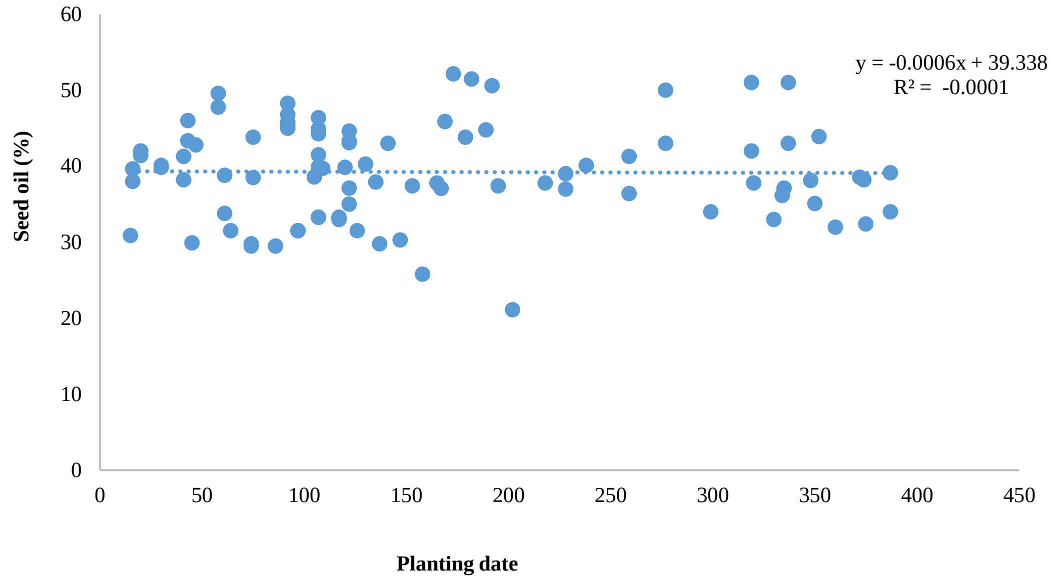

Figure 10. Response of GOP to planting dates (p-value=0.4947, N =91)

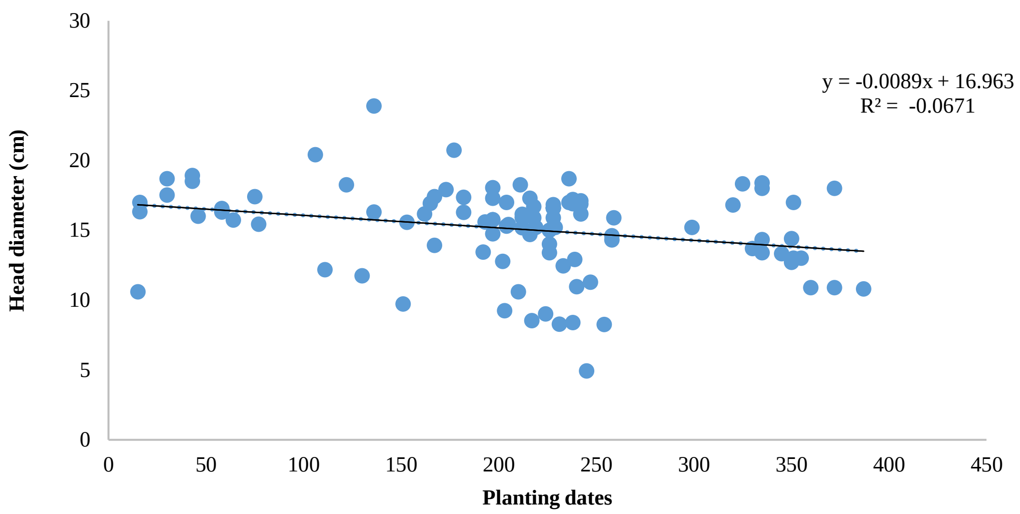

Figure 11. Response of HD to planting dates (p-value=0.4861, N =99)

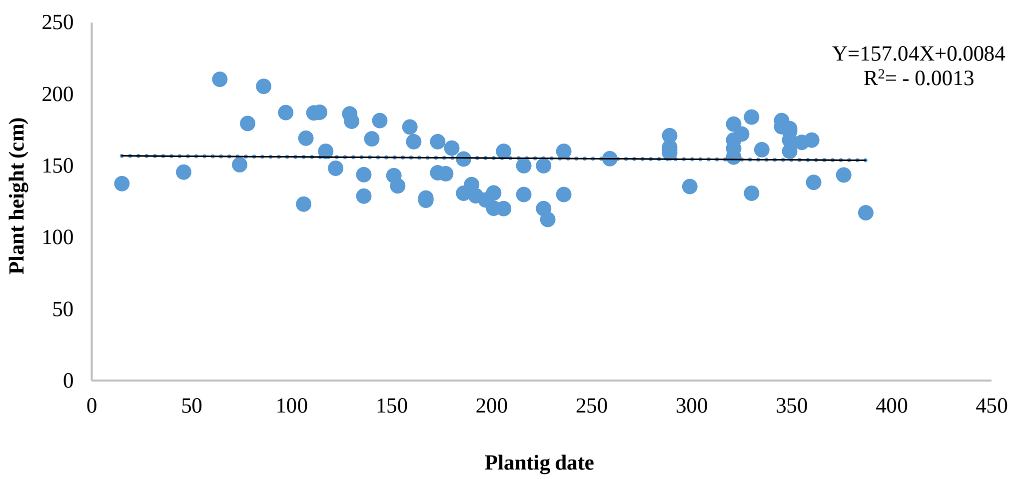

Figure 12. Response of PH to planting dates (p-value=0.4652, R^2= 0. 0013, N =70)

Studies	Effect size
Osuonda et al., 2014	-4.49
Salim et al., 2007	-7.41
Hendei ,2015	-6.71
Hendei , 2015	-6.51
Hendei , 2015	-7.54
Akhtar et al., 2005	-1.71
Akhtar et al., 2005	5.91
Duta, 2011	-2.29
Mirchekaariet al., 2001	-13.4
Gholipoor et al., 2011	-68
Ahmad et al., 2015	-2.07
Qadiret al., 2007	-10.56
Rajabi et al., 2013	-0.47
Dadashian et al., 2007	-27.26
Elsir et al., 2017	-0.34
Elsir et al , 2017	4.62
Mazaheri laghab et al., 2010	-12.59
Moradiaghdam et al., 2010	0.3
Ahmad et al., 2015	5.72
Qadir et al., 2007	-75.36
Haerinejad et al .,2010	1.67
lawel et al .,2011	-4.57
lawel et al.,2011	-5.78
Zamani et al.,2001	-4.45

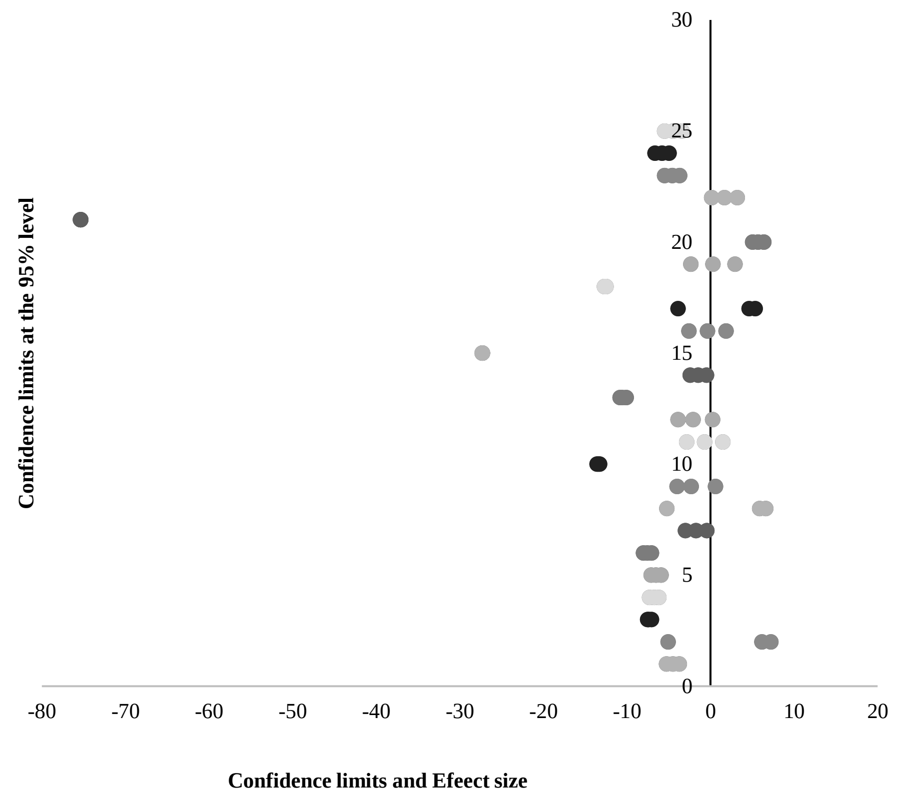

Figure 13. Accumulation chart displaying an inverse-variance weighed random effect meta-analysis of the effect of GY under planting dates

Studies	Effect size
Oshinduia et al., 201	-1.75
Salim et al., 2007	-3.28
salim et al.,2007	-3.11
Akhtar et al., 2005	3.25
Akhtar et al., 2005	9.47
Moradiaghdam et al.,	-0.32
Mirshekari et al., 20	-4.26
Golipour et a., 2010	-0.6
Baboul et al., 2015	-1.49
Baboul et al., 2015	0.66
Qadir et al., 2007	-46.2
Haerinejad et al., 201	4.48
Rajabi et al., 2013	-0.65
Reo et al., 2012	0.25
Zamani et al ,2001	-1.55
Mazaherilaghab et al., 2012	-0.73
Kiliy et al., 2005	-4.27
Daneshyan et al., 20	-2.99

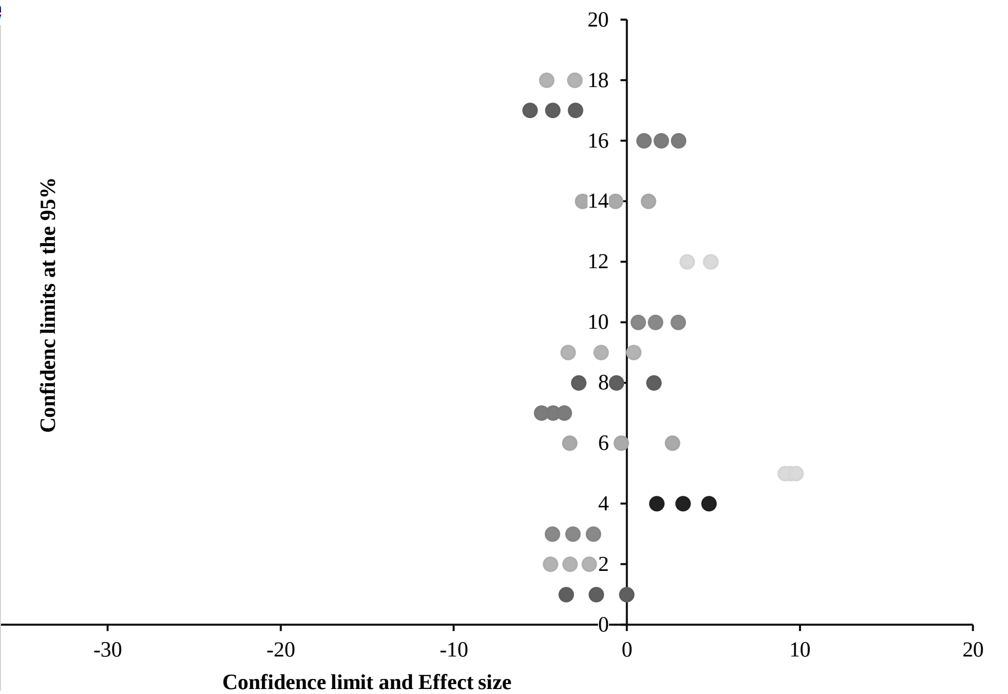

Figure 14. Accumulation chart displaying an inverse-variance weighed random effect meta-analysis of the effect of GN/H under planting dates

Studies	Effect size
Hamza et al., 2014	4.11
Salim et al., 2007	-7.95
Salim et al., 2007	-2.47
Hendei et al., 2015	-9.79
Akhtar et al., 2005	9.73
Akhtar et al., 2005	8.72
Moradiaghdam et al., 2010	-1.68
Elsir et al., 2017	-19.56
Mirshekari et al., 2012	-4.21
Gholipour et al., 2010	-0.66
Ahmad et al., 2015	-2.2
Haerinejad et al., 2012	-1.1
Rajabi et al., 2013	-2.42
Mazaheri laghab et al., 2010	-1.32
ahmad et al., 2015	-15.71
Khalil et al., 2005	-1.83
Salim et al., 2015	-1.92
Salim et al., 2015	9.76
Dadashian et al., 2008	5.16

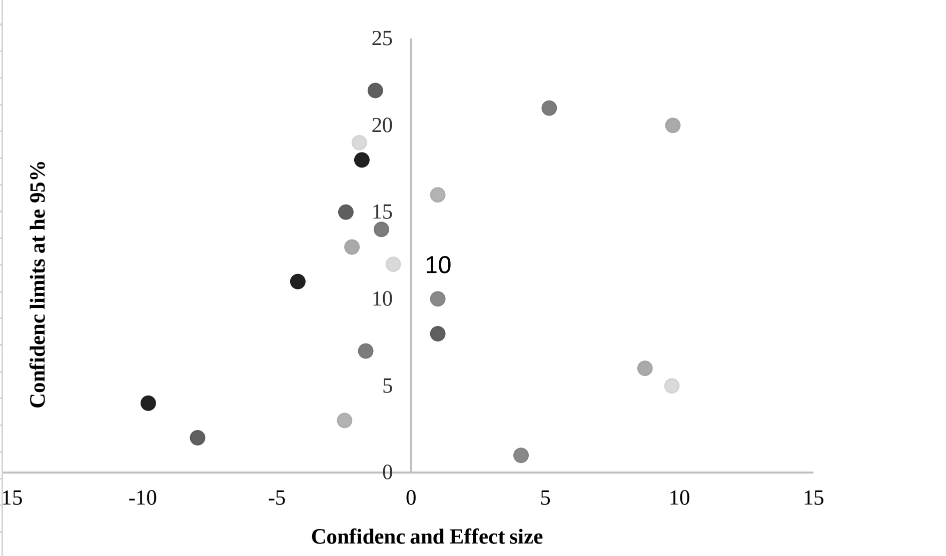

Figure 15. Accumulation chart displaying an inverse-variance weighed random effect meta-analysis of the effect of TGW under planting dates

Studies	Effect size
Esechie , 1995	0.61
Esechie, 1995	-0.3
Hamzeh et al., 2013	1.01
Radoji et al., 2013	10.75
Salim et al., 2007	3.77
Hendei, 2001	-10.29
Akhtaret al., 2005	7.51
Akhtar et al., 2005	-0.63
Golipour et al., 2010	0.12
Mazaheri laghab et al., 2001	14.63
Khalil et al., 2005	-1.83
Dikkion et al., 2107	-3.94
Petco et al., 2012	-2.11
Dikkion et al., 2107	-9.41
Petko et al., 2012	0.43
Petko et al., 2012	-9.57
Salim et al., 2007	-3.29
Salim et al., 2007	16.09
Dikkion et al., 2107	0.3
Petko et al., 2012	-10.61

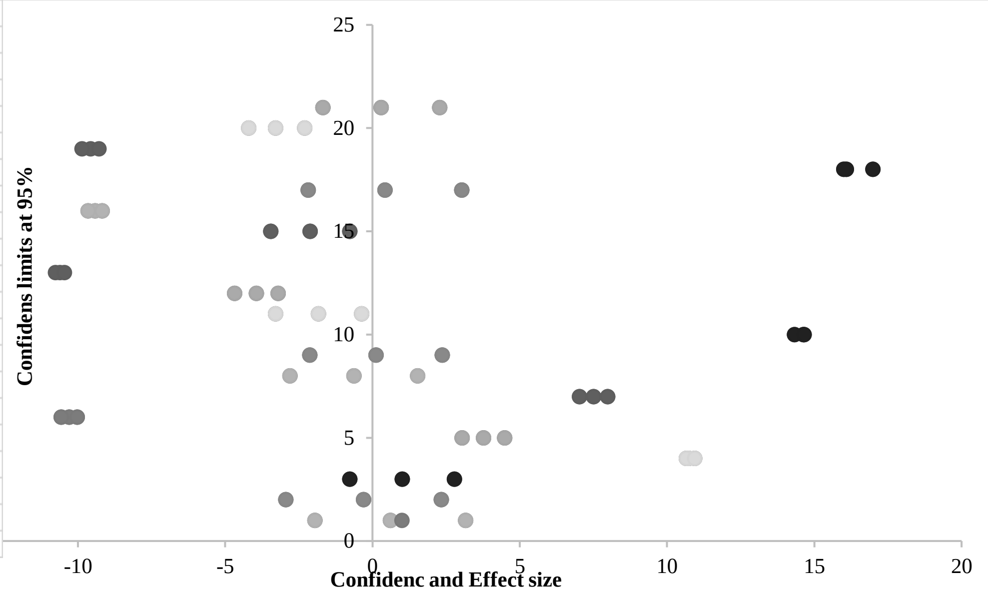

Figure 16. Accumulation chart displaying an inverse-variance weighed random effect meta-analysis of the effect of GOP under planting dates

Studies	Effect size
Bagherpour et al., 2013	0.06
Radoji et al., 2015	-1.05
Radoji et al., 2015	-0.28
Salim et al., 2007	0.04
Salim et al., 2007	-0.46
Hendei , 2015	-1.6
Akhtar et al., 2005	0.74
Akhtar et al., 2005	0.83
Elsir et al., 2017	0.63
Elsir et al., 2017	-0.76
Duta , 2011	-2.07
Mirshekari et al., 2012	-0.71
Gholipour et al., 2011	0.04
Ahmad et al., 2015	-1.84
Ahmad et al., 2015	-1.74
Haerinejad et al., 2009	0.64
Rajabi et al., 2015	-0.17
Lawel et al., 2011	-1.04
Lawel et al., 2011	-1.36
Hamza et al., 2014	-0.31
Bagherpoor et al., 2013	5.77
Bagherpoor et al., 2013	0.04
Radoje et al., 2016	0.53

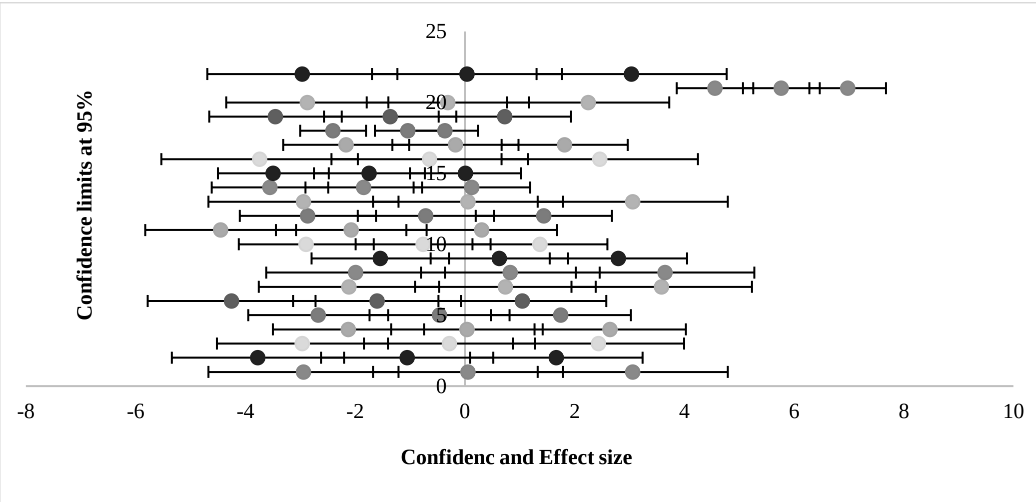

Figure 17. Accumulation chart displaying an inverse-variance weight random effect meta-analysis of the effect HD under planting dates

Studies	Effect size
Hamza et al., 2013	0.9
Hendeil et al., 2015	-1.06
Moradiaghdam et al., 2010	-1.07
Elsir et al., 2017	0.24
Elsir et al., 2017	-0.13
Mirshekari et al., 2012	-8.78
Ahmad et al., 2015	-0.4
Haerinejad et al., 2010	-32.1
Rajabi et al., 2015	-0.09
Duta , 2011	-8.64
Shfieipour et al., 2010	-0.91
Shafieipour et al., 2010	-0.74
Esechie, 1995	3.04
Esechie, 1995	1.26
Esechie, 1995	-0.1
Esechie, 1995	-0.29
T.a.et al., 2012	0.37
Killy, 2005	-6.68
Moradiaghdam et al., 2010	-1.49
Rajabi et al., 2015	-0.07

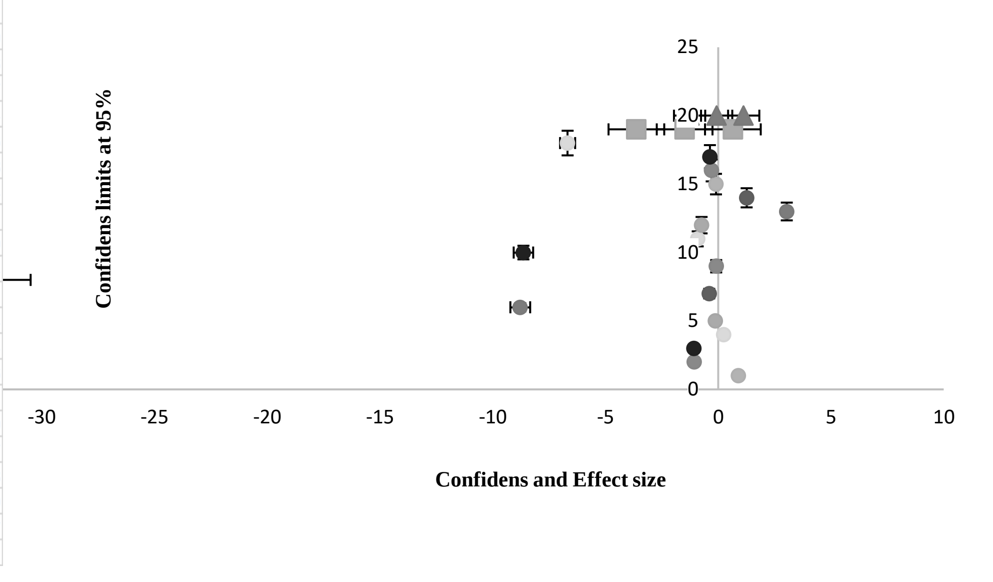

Figure 18. Accumulation chart displaying an inverse-variance weighed random effect meta-analysis of the effect of PH under planting dates

3.3. Accumulation diagrams

With the mean weight of articles and 95% confidence interval -1.14 (23.55, -25.83) for equal grain yield, it was shown that the highest additive effect of planting date (+6.15 with increase 800 kg) to the study Ahmad et al. (2015), and had the least negative effect of reduction (-75.36 with increase 250 kg) according to the study of Gadir et al. (2007) among 25 studies, 21 studies had a positive charge and 4 articles had a negative charge (Figure 13). were placed out of funnel, it can be showed according the validity of the funnel diagrams 9 and 4 that they had a lower reference rate.

In the accumulation diagram for the GN/H according to the mean effect size and 95% confidence interval -0.75 (28.66, -30.16) in the head also the most positive incremental effect of planting date (+4.48) to study Haaerinejad et al. (2010) and the least negative reduction effect -46.2) was related to the study of Ghadir et al. (2007). Out of 18 articles, 17 articles had a positive charge and 1 article had a negative charge (Figure 14). Had a low validity and the funnel1 and 24 of the funnel diagrams showed that they were out of reference studies.

According to the results of the accumulation diagram of 22 studies out of 40 studies for TGW, mean effect size and 95% confidence interval -2.22 (19.9, -24.34) The least negative effect of planting date (-15.71 with increase 6 g) to study Mazaherilaghab et al. (2011) and the highest positive effect (9.76 with increase 6 g) and the lowest confidence interval of the study Salim et al. (2015), among 22 articles, 16 articles had a positive charge and 6 articles had a negative charge. (Figure 15). According to the accumulation diagram of grain oil, mean effect size and 95% confidence interval 0.07 (26.51, -26.37), highest positive incremental effect (+16.09), date of planting to study Salim et al. (2015) and lowest negative effect of planting date (-10.61) belonged to the study Gheorghe and Elena. (2012), among 22, 18 articles have a positive charge and 4 articles have a negative charge (Figure 16). HD trait with mean effect size and confidence interval of -0.32 (55.68, -56.32) 95% had the highest incremental effect of planting date (+6.98) and the lowest confidence interval in the study Akhtar et al. (2005) and the lowest negative effect of planting date (-4.45) belonged to the study Duta. (2011) Among 24 studies, 10 articles had a positive charge and 14 articles had a negative charge (Figure 17). For PH trait, mean effect size and 95% confidence interval -0.51 (36.03, -37.05) the least decreasing effect of planting date (-8.78 lowest confidence interval belonged to the study of Mirshekari et al .2012 (1995) highest incremental effect of planting date (+1.26) belonged to the study of Esechie (1995). Out of 20studies, 16 articles had a positive charge and 4 articles had a negative charge (Figure 18).

3.4. Drawing funnel plots and bias studies

By the test, we can observe that the symmetry hypothesis is rejected. It cannot be excluded that there was a certain publication bias within the results. In order to find out whether there was a publication bias in the meta-analysis “funnel plots” were used to detect a possible publication and location bias in this study we didn't have access to the authors and it was too time consuming. we could not gather the articles which had not been published in valid journal. In the other hand, as some of the resources had been published for a short time, we didn't have access it the details of the studies. The reason why the diagrams are asymmetrical in different characteristics is that most of the articles had a low effect size. There were few articles with high effect size. Our meta-analysis was based on local and foreign studies, so we had to use the studies published in scientific research journals and reliable scientific conferences.

CMA version 3.0 software was used to draw the funnel diagram and bias**.** The program is looking for missing studies based on a fixed effect model, and is looking for missing studies only to the right side of the mean effect (these parameters are set by the user). he method is known as 'Trim and Fill' as the method initially trims the asymmetric studies from the left-hand side to locate the unbiased effect (in an iterative procedure), and then fills the plot by re-inserting the trimmed studies on the left as well as their imputed counterparts to the right the mean effect. In the drawn funnel charts, the filled circles are filled with studies that are statistically significant at the 5% level, their p-value is less than 5%**.** Funnel diagram of GY of 22 articles, the seed yield bias showed that 4 studies were out of the funnel, which is not statistically significant at the 5% level (open circles) (Figure 19). In biasing the attribute number of seeds in 6 studies from the right side had a significant p-value at the 5% level, and with the trim test, only one study left the funnel (filled circle) (Figure 20).

In the trait bias of seed oil percentage, it was shown that 4 studies were statistically significant at the 5% level, and 3 studies were excluded from the funnel (filled circle) (Figure 21). Also, two studies were excluded that were not statistically significant at the 5% level (Your circle is empty)**.** In the bias of 1000 seed weight trait, 6 studies are statistically significant at the 5% level, and out of these 6 studies, two studies were out of the funnel (filled circle), which do not have good statistical validity. The number of 3 studies was not statistically significant at the 5% level (open circles) (Figure 22). According to the bias of the diameter attribute, the studies that were outside the funnel were not statistically significant at the 5% level (open circles) (Figure 23). The height trait bias showed that 5 studies were statistically significant at the 5% level, and 3 studies were out of the funnel (filled circles). 5 studies were

out of the funnel, which is statistically significant at the level of 5%, their p-values are not significant (open circles) (Figure 24).

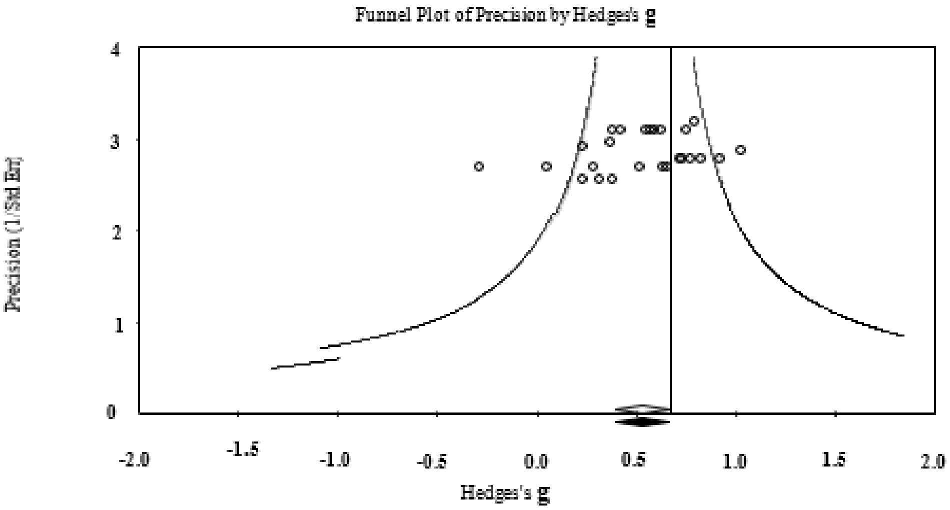

Figure 19. Funnel plot for GY (kg. ha^{-1}). Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

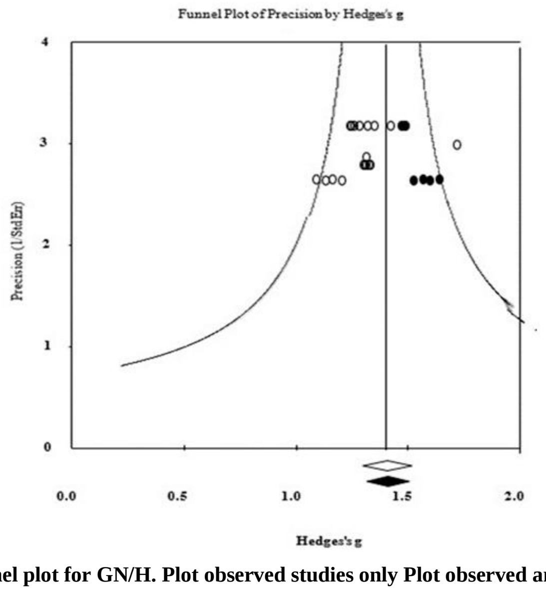

Figure 20. Funnel plot for GN/H. Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

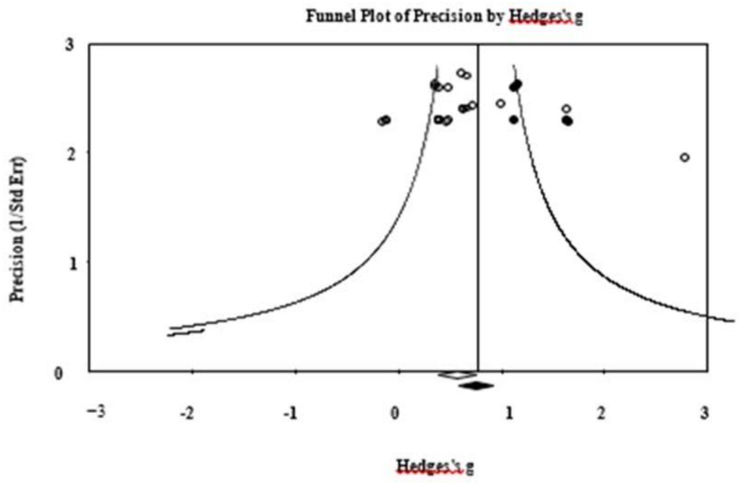

Figure 21. Funnel plot for GOP (%). Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

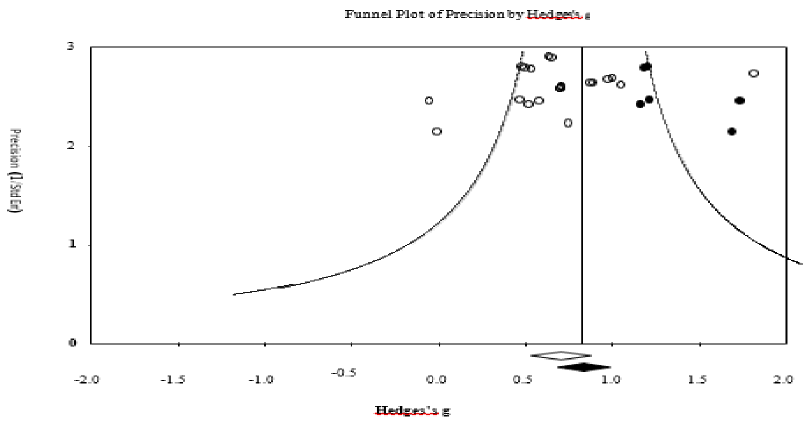

Figure 22. Funnel plot for TGW (g). Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

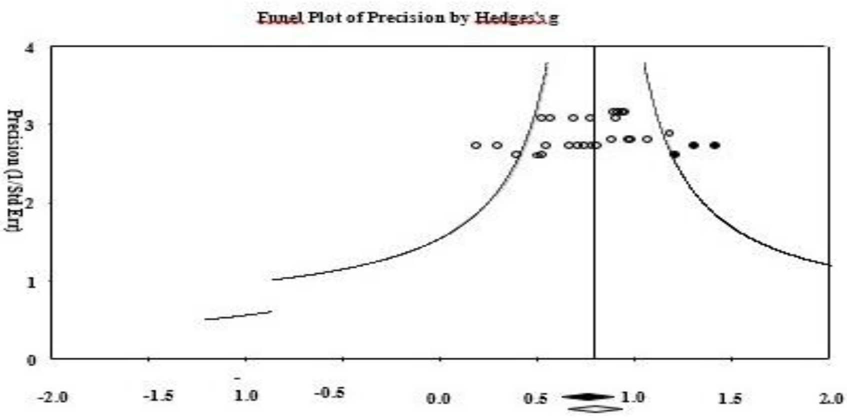

Figure 23. Funnel plot for HD (cm). Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

4. Discussion

In this study, we seek to investigate the effects of planting date on yield and yield components and some morphological traits and qualitative yield such as GOP in sunflower oil. Planting sunflower oil among 40 articles has been done in spring in cold to semi-cold regions and winter planting in semi-warm to warm regions. Given that the physiological zero of the plant is 7-10° C (Zamani et al. 2005; Ghadir et al. 2007; Qadir et al. 2013). Therefore, the best time to plant oil sunflowers in Iran and the world for spring planting in mid-May to mid-June (80-170 JD), and in subtropical to tropical regions from mid-February to mid-March (1-80 JD). The results of this study showed that the planting date range is 1-170 JD, significantly affected on GY, TGW, HD, GN/H (Figures 2, 3, 4 and 5). The mentioned traits had an increasing trend under the influence of planting date (Figures 7, 8, 9, 11). The effect of planting date on the GOP in the range of 263-387 JD range was significant (Figure 6). According to the regression diagram, the GOP under the influence of planting date was associated with a decreasing trend (Figure 10). Environmental factors have affected the growth of hazelnut, GOP, oil yield and its quality. Among environmental factors, temperature is considered as the most important factor and changes in planting date change the temperature of each of the phenological stages. The growth and development of the plant is effective, so the appropriate planting date, while affecting the rate of vegetative growth and increasing plant vigor for the more developed reproductive part, increases the number of flowers and seeds in plant. Early sowing of sunflower due to the temperature below zero is physiologically suitable, causes no seed germination and seed contamination at the time of germination. Early planting in saline soil has been effective in improving GY, TGW, GN/H (Kochehbaghi et al., 2009).

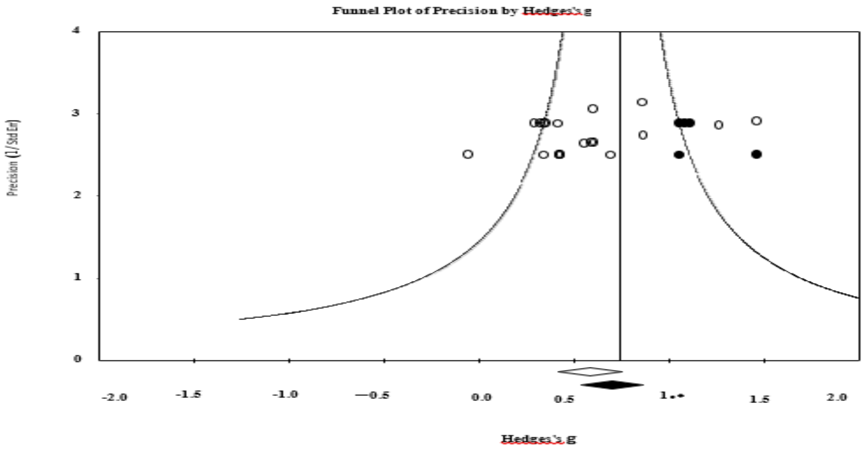

Figure 24. Funnel plot for PH (cm). Plot observed studies only Plot observed and imputed (○) Plot observed and imputed (●)

According to Figure 6, GY and grain oil yield traits are obtained in early spring planting dates and the amount of these traits will be reduced with planting delay. Early planting date does not have much effect on increasing yield, but due to increasing the length of the plant growth period, it will delay the next planting and increase costs and thus reduce the farmer's income. Matching delayed planting in many cases, the plant faces high temperatures during the growing season, which in turn increases the initial growth of the stem and reduces the length of the flowering period. Various studies by Johnson et al., (1972), Andrade (1995), Uger and Thomson (1982) showed that high GY in sunflower when the grain development stages are at moderate temperatures, is achieved. Environmental factors affect the HD trait according to sunflower more than genotype so that with delay in planting and facing unfavorable environmental conditions, especially high temperatures, the growth period of the plant is shortened and the average HD per plant is reduced (Figure 2). For this reason, the longer the growth period of the plant delay of planting date to temperature above zero is physiological germination in the region reduces germination power and reduces the growth and delay of seedling emergence and thus reduces PH. The PH depends on the selected genotype and other factors such as nitrogen fertilizer application rate, soil type, soil salinity, planting density (Figure 1). Delay of sowing from the optimal time significantly reduces GY by reducing the number of grains produced per square meter and lack of late planting date also not only reduces yield due to reduced growth period and consequently reduces the efficiency of using environmental resources air and soil (Figure 4) but also due to the time of harvest with autumn rainfall, causes Obstacles to be created for the next crop planting time in rotation. According to José et al. (2004) planting dates 101, 103, 110 and 125 JD, for four consecutive years, no suitable trend and relationship was observed between planting date and TGW, but a significant relationship was observed between planting date and increase in the number of grains per square meter (Figure 5). Meta-analysis of each study showed that the highest TGW gain (9.76) on planting date is in mid-August (228 JD), the highest PH by weight (3.04) on planting date is 2 December (347 JDD), the highest performance increase with weight (41.64) is on March 15 (74 JD), The highest increase in the GN/H, by weight (9.79) on the date of sowing February 13 (44 JD), the highest increase in the GOP by weight (21.71) on the date of sowing is in mid-September (259 JD). The largest increase in the HD with weight (4.35) on planting date is August 29 (242 JD), d among the 40 meta-analytic studies were associated. Therefore, according to the final goal in this study, the best sowing date in terms of GY can be obtained in the planting date of 1-80 JD due to the increase in the GN/H. Also, the best treatment for planting date was achieved to the maximum yield of grain oil in the range of 171-263 JD. The purpose of investigating changes in planting date in 40 studies based on meta-analysis was to achieve the desired temperature for all important phenological stages of the plant that face the desired temperature and are safe from temperature stress, which can be based on latitude and longitude for similar areas from these favorable planting dates to achieve more economic production.

5. Conclusion

In this meta-analysis, we found that delay in sowing date reduced traits such as GY, GN/H, GOP, PH, HD, but had a positive effect on TGW and an increasing trend was observed. Also, for the GOP, there were very few changes at the same time as the planting date changes. Due to the dispersion of the studied sites in 40 articles, the contradictory results confirm that the effects of planting date are not the main reason for the changes in the measured traits and should be due to other variables such as plant cultivar, crop input management and geographic coordinates. The geographical location of the farm should be considered in meta-analysis. The increasing trend of the studied traits was observed according to the effect intensity diagrams and the mean of the traits in the range of planting date 1-117 JD. According to the results of funnel diagrams, the selected articles were heterogeneous in such a way that the negative and positive effects of planting date were observed and the range of planting date was varied and the contradictory results were not unexpected. According to the accumulation diagrams, changes in the studied traits are not dependent on planting dates, so planting date is not considered as the main factor affecting the GY and its GY components in oil sunflower. The best time for spring planting is in mid-may to mid-June (80-170 JD) and in subtropical to tropical regions, from mid-February to mid-March (1-80 JD). The present results support such a relationship. Based on the present results and due to the homogeneity. In these 25 articles, considering the results of meta–regression no negative correlation was seen in the traits of the number of seeds in plate and the yield. But for other traits no correlation was seen. In the other hand the results of the accumulation chart also showed that the minimum and the maximum effect size were related to the studies that in addition to the cultivation date had studied the cultivar and cultivation methods including Cultivation density. The differences of the studies based on the funnel diagram in the three characteristics of GOP, GN/H, HD and TGW showed that in these studies, differences can be seen both between studies and within studies. Therefore, meta-analysis of other factors is also necessary.

References

Ahmed, B., Sultana, M., Zaman, J., Kumar, S. P., Mokhlesur Rahman, M. D., Rezaul Islam, M. D., & Majumdar, F. (2015). Effect of sowing dates on the yield of sunflower. *Bangladesh Agronomy Journal*, *18*(1), 1-5. **doi: 10.3329/baj.v18i1.25561**

Ahmad, S., & Hassan, F. U. (2000). Oil yield and fatty acid composition of spring sunflower. *Pakistan Journal of Biological Sciences*, *3*, 2063-2064. **doi: 10.3923/pjbs.2000.2063.2064**

Abdu, S. M. M., Abd El-Latif, K. M., Farrag, R. M. F., & Yousef, K. M. R. (2011). Response of sunflower yield and water relations to sowing dates and irrigation scheduling under Middle Egypt condition. *Advance Applied Science Research*, *2*(3), 141-150.

Akhtar, N., & Malik, M. A. (2005). Effect of planting dates and irrigation levels on achene yield and oil contents of spring sunflower. *Journal of Agriculture Research*, *43*(2), 145-154.

Ashley, R. O., Carr, P. M., Martin, G., Whitney, B., & Peterson, H. (2001). Sunflower date of planting study in western North Dakota. Annual Report 2001, Dickinson Research Extension Center, Dickinson, ND, 187-198.

Andria, R., Chiaranda, F. Q., Maglivlo, V., & Mori, M. (1995). Yield and soil water uptake of sunflower sown in spring and summer. *Agronomy Journal*, *87*, 1122-1128. **doi: 10.2134/agronj1995.00021962008700060014x**

Awais, M., Wajid, A., Ahmad, A., Farrukh Saleem, M., Usman Bashir, M., Saeed, U., Hussain, J., Ur-Rahman, M., & Habib, M. (2015). Nitrogen fertilization and narrow plant spacing stimulated sunflower productivity. *Turkish Journal of Field Crops*, *20*(1), 99-108. **doi: 10.17557/.17374**

Bagheripour, M., Asad Abadi, A., & Akbarian, M. M. (2013). Study the effect of varieties and planting date on sunflower production (*Helianthus annuus* L). *Annals of Biological Research*, *4*(7), 41-46.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). Introduction to meta-analysis (1st ed.). West Sussex, UK: Wiley and Sons.

El Sir, A. I., Abdallah Adlan, A. A., Ezeldeen, M., Banaga, A., & Omima, B. H. (2017). Effects of sowing date on sunflower (*Helianthus annuus* L.) yield and yield components under rainfed conditions in Blue Nile State, Sudan. *Merit Research Journal of Agricultural Science and Soil Sciences*, *5*(3), 060-063.

El-Saied, S. K. H., El-Ahmer, B. A., El-Sergei, D. Z., & Guirguis, N. R. (1989). Response of sunflower varieties to different sowing dates. *Minia Agricultural Research*, *11*(3), 1485-1504.

Esechie, H. A. (1995). Effect of planting date on the growth and yield of irrigated sunflower (*Helianthus annuus* L). *Journal of Agronomy and Crop Science*, *175*, 41-49. **doi: 10.1111/j.1439-037X.1995.tb01127.x**

Darby, H., Harwood, C., Cummings, E., Madden, R., & Monahan, S. (2012). Sunflower planting date trial. University of Vermont Crops and Soils Technicians Technical Report, 524-6501.

De La Vega, A. J., & Hall, A. J. (2002). Effects of Planting Date, Genotype, and Their Interactions on Sunflower Yield: I. Determinants of Oil-Corrected Grain Yield. *Crop Science*, *42*(4), 1191-1201. **doi: 10.2135/cropsci2002.1202**

Dutta, A. (2011). Effects of sowing dates on yield and yield components of hybrid sunflower (Helianthus annuus L) in nontraditional areas of West Bengal. *Journal of Crop and Weed*, *7*(2), 226-228.

Johnson, B. J., & Jellum, M. D. (1972). Effect of planting date on sunflower yield, oil, and plant characteristics. *Agronomy Journal*, *64*, 747-748.

Jose, F. C., Barrosa, B., Mario de Carvalhoa, B., & Gottlieb, B. (2004). Response of sunflower (Helianthus annuus L.) to sowing date and plant density under Mediterranean conditions. *European Journal of Agronomy*, *21*, 347-356. **doi: 10.1016/j.eja.2003.10.005**

Gheorghe, S., & Elena, P. (2012). Effect of sowing date and plant density on sunflower yield and its main components. National Agricultural Research and Development Institute Funduleano, 29(44), 135-144. **doi: 10.2298/hel0644135p**

Golipoor, H., Siyadat, A., & Mojadam, M. (2010). The effect of different planting dates on yield and yield components of sunflower seeds in Shahinshahr, Isfahan. *Journal of Crop Physiology*, *3*(9), 3-13.

Hamza, M., & Safina, S. A. (2015). Performance of sunflower cultivation in sandy soil at a wide range of planting dates in Egypt. *Iranian Journal of Field Crops Research*, *14*(4), 686-698. **doi: 10.21608/jpp.2015.49782**

Hedges, L., Gurevitch, J., & Curtis, P. (1999). The meta-analysis of response ratios in experimental ecology. *Ecology*, *80*, 1150-1156.

Hedges, L. V., & Olkin, I. (1985). Statistical methods for meta-analysis. New York: Academic Press.

Henedi, M. M. (2015). Evaluating the correlation between yield and yield components in sunflower under different planting dates. *International Journal of Agricultural Sciences*, *5*(3), 541-550.

Haerinejad, S., Madani, H., & Sadeghzadeh, S. (2010). Effect of planting date on yield and components and oil seed sunflower in Rodab-Iran. *Journal of New Agriculture*, *6*(2), 119-126.

Killi, F. A. T. I. H., & Altunbay, S. G. (2005). Seed yield, oil content and yield components of confection and oilseed sunflower (*Helianthus annuus* L.) cultivars planted in different dates. *International Journal of Agriculture and Biology*, *7*(1), 21-24.

Khalifa, F. M., Schneiter, A. A., & Eltayeb, E. I. (2000). Temperature-germination responses of sunflower (*Helianthus annuus* L.) genotypes. *Helia*, *23*, 97-104. **doi: 10.1515/helia.2000.23.33.97**

Khalil, L. A., Shah, F., Yasmeen, & Mumtaz, M. A. (2000). Seed yield and fatty acid profile of sunflower hybrids. *Sarhad Journal of Agriculture*, *16*, 601-604.

Lawal, B. A., Obigbesan, G. O., Akanbi, W. B., & Kolawole, G. O. (2011). Effect of planting time on sunflower (Helianthus annuus L.) productivity in Ibadan, Nigeria. *African Journal of Agricultural Research*, *6*(13), 3049-3054.

Qadir, G., Ul-Hassan, F., & Azim Malek, M. (2007). Growing degree days and yield relationship in sunflower (*Helianthus annuus* L). *International Journal of Agriculture and Biology*, *11*(2), 135-123.

Rahimzadeh, R., & Najafi Mirak, T. (2009). Effect of planting method and plant density on yield and agronomic traits of sunflower in rainfed conditions. *Iranian Journal of Crop Sciences*, *2*(11), 123-135.

Radooji, A., Sayedi, N., & Neamati, M. (2015). Possibility of planting new sunflower cultivars in autumn in Gonbad rainfed conditions. *Iranian Journal of Rainfed Agriculture*, *4*(2), 189-227. **doi: 10.22092/idaj.2016.106101**

Rajabi, M., Faraji Arman, M. H., & Ghatari, M. (2013). Effect of normal and late planting date on yield and yield components of sunflower cultivars in hamadan climatic conditions. *Journal of Modern Knowledge of Sustainable Agriculture*, *2*, 21-30.

Salim, S. F. Hassan, I. Mahmood, M. R. Ullah, A. & Ahmad, M. (2011). Response of sunflower to environmental disparity. *Nature and Science Journal*, *9*(2): 73-81.

Sharief, A.E. (1998). Productivity of some introduced sunflower cultivars as affected by planting date and plant population density. *Zigzag Journal and Agricultural Research*, *25*(6): 895-909.

Shafeiepoor, H., Saeedisar, S., Nadali, F., & Mohammadi, A. (2010). Effect of planting date and seed pretreatment on phenological stages, morphological characteristics and yield of sunflower seeds. *Journal of agricultural research*, *3*(1), 103-131.

Mazaheri Laghab, H. F., Noori Zare Abyaneh, H., & Vafaie, H. M. (2001). Effects supplemental irrigation on traits of three cultivars of sunflower in dry farming. *Journal of Agricultural Research*, *3*(1), 31-44.

Mirshekari, B., Koucebagh S. B., Valizadeh, N., & Roudsari, A. M. (2010). Interference of redroot pigweed in sunflower hybrids. *Journal Food, Agriculture and Environment*, *8* (3 and 4), 810-814.

Moradi Aghdam, A., Dashain, J., Zakirin, H., Ghafari, M., Haji Hosni Asl, N., Moradi Aghdam, M., & Valinejad, H. (2010). The effect of planting date on phenology and some agronomic characteristics of oil sunflower cultivars in Khoi, *Ecophysiology of Agricultural Plants*, *3*(3),Pp:205-215

Zakerin, G., Ghafari, J., Hajhossini, M., Asl N., Moradiagdam, M., & Valinegad, H. (2010). The effect of planting date on phenology and some agronomic characteristics of oil sunflower cultivars in Khoi. *Journal of Crop Plants Ecophysiology*, *3*(3), 205-215.

Oyinlola, E. Y., Ogunwole, J. O., & Amapu, I. Y. (2010), Response of sunflower to nitrogen application in *Asavanna alfisol*. *Helia*, *33*(52), 115-126. **doi: 10.2298/hel1052115o**

Zamani, A., & Fourozesh, P. (2001). Effect of date of plant on phenology and yield and component yield in sunflower. *Agronomy Journal and Village Development*, *4*, 53-64.

Oshundiya, F. O., Olowe, V. I. O., Sowemimo, F. A., & Odedina, J. N. (2014). Seed yield and quality of sunflower (*Helianthus annuus* L.) as influenced by staggered sowing and organic fertilizer application in the humid tropics. *Helia*, *37*(61), 237-255. **doi: 10.1515/helia-2014-0012**

Uger, P. W., & Thomson, T. G. (1982). Planting date effect on sunflower in the Texas plains. *Agronomy journal*, *78*, 507-515. **doi: 10.1080/01904167.2012.724138**