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Study of Agronomically Important and Physiological Traitson Quantitative and Qualitative Yield of 15 Genotypes of Domestic and Forign Safflower

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This experiment investigates a number of selected genotypes of safflower tocompare seed yield and oil percent in order to achieve high yield and high oilcultivars. 15 genotypes were studied . The experiment was conducted in a randomized complete block design with four replications. Parameters measured during the study includ seed yield, oil percentage, oil yield per hectare , effective pod number per plant, number of seeds per head, number of affecting branches in plant, height from soil surface, a thousand seed weight, biological yield per plant (biomass), harvest index, days to start bud, days to start flowering, days to 50 % flowering , days to end of flowering and days to maturity. After the traits measurement , the binary correlation between the traits was performed and correlation coefficients were calculated . The results of variance analysis showed that there is a significant diference at 1% among varieties for all traits except harvest index, the number of days to flowering, the number of days to end of flowering and the number of days to maturity. Golemehr with 3050 kg seeds and Padideh with 3059kg seeds per hectar were identified best cultivars among the varieties. Thorn less white flowerscultivars with 3011 kg seeds per hectare were placed at statistical class a. However, it should be noted that this cultivar due to the lack of colorful florets and Padideh cultivar due to thornscould not compete with Golemehr cultivar. Mec-7 cultivarwith 31.63 percent, and Mec-248 with 32 percent were the best varieties of the seed oil content. Thorn less white flowers cultivarwith 972 kg seeds per hectar, Golemehr cultivar with 878 kg seeds per hectar and Padideh cultivar with 863 kg seeds per hectar had the highest oil yield. Traits such as pod number per plant, biomass, oil yield, seed number per pod, number of branches and height show a significant positive correlation with seed yield per hectar and caused increased seed yield in sawflower yeild. Traits such as pod number per plant, seed at pod, height, biomass and seed yield show significant positive correlation with oil yield.

Key words: Safflower, SeedYield, Oil Percentage, Oil Yield, Agronomic Traits, Yield Components, Traits Correlation.

Oils and fats are the second largest source of human energy requirements after carbohydrates. Nutritionists believe that every individual should gain 15 to 30 percent of its energy needs through these materials on a daily basis that are the one of the most important sources of edible oils. Today the human need for oilseeds production has increased over time;so that the production of oilseeds has become one of the important objectives in agriculture. Oils in addition to human nutrition are used in industrial applications in many fields, livestock and poultry feed, medical use, cosmetics, etc. safflower with the scientific name

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of (Carthamustinctorius L.) is a plant full of foliage, herbaceous, annual, and belongs to (Compositae) or Stras ·h (Asteraceae). Safflower homestead farm is trapped between the Eastern Mediterranean and the Persian Gulf region. Some sources have noted that the crop originated in South Asia and has been cultivatedin China, India, Iran, and Egypt. Safflower is cultivated in more than 60 countries among them India cultivates about half of the crop worldwide[1]. In all plants there is a general principle that If there is a possibility of soil testing, it needs to determine the amount of fertilizer in different cultures using soil test results. This has three major advantages; First, the savings in fertilizer which is economically affordable; second, the problem of excessive use of fertilizers and toxic soil will be removed and the third, it may be possible to provide each plant with most appropriate recommended quantities of fertilizer in scientific experiments and then achieve the highest yield.

A group of researchers did research on Safflower plant height. The results of these experiments show values of 80 and 120 kg per hectare will result in the attainment of the highest plant height; and there was no significant difference between 80 and 120 kg values. There was a significant correlation between the number of pods per plant and the amount of nitrogen fertilizer intake,so that the amount of 120 kg per hectare fertilizer produces the greatest number of pods. Ammonium nitrate fertilizer shows the highest yield while ammonium sulfate fertilizer application bears the lowest seed yield.Observations show that fertilizer form of application and fertilizer levels had no significant effect on oil percentage, which is consistent with another group of researcher's results in India[2]. A team of researchers began to investigate the seed yield and oil yield. This experiment show a significant positive impact of nitrogen fertilizer on increased seed yield and oil yield and suggest that the use of ammonium nitrate fertilizer of 120 kg per hectare is appropriate and can lead to the best seed yield and oil yield among other conditions. Moreover, in another experiment the significant effect of nitrogen fertilizer on yield and safflower oil are referenced and the highest seed yield is obtained in the form of ammonium nitrate fertilizer[3]. In recent years, the dried safflower florets are used to treat diseases in women, cardiovascular disease and stroke, high blood pressure and diabetes. In Japan, the red pigment of safflower (carthamin) is mainly used in chocolate coloring and yellow pigment (carthamidin) because it is soluble in water, is used as a natural dye color to the beverages, syrups, jellies and candies for years[4]. Red and yellow pigments derived from safflower florets, are natural without risk and safe pigments can be used for food coloring, clothes and cosmetics[5]. Safflower fields can be used for grazing and either fresh or dry storage silo can be used to feed livestock. The leaves and stems of safflower are good feed to animals. Safflowers leaves are tasty, nutritional with a performance similar to or better than oats and hay, and could be considered as suitable forage[6].One other application of safflower seed is in feeding birds. Today, safflower is planted for oil in their seeds that is used in different fields of application[7]. Correlation coefficients of seedweight per pod, a thousand seed weight and seed yield and capsule diameter are 0.79, 0.67 and 0.77 respectivelyand showed that these parameters are have the strongest effect on seed yield. Also, in this experiment, the number of pods per plant, the number of seeds per pod and seed number per square meter were not significantly correlated with seed yield[8]. A test on 50 safflower lines reflects the fact that seed per pod, the number of pod per plant and a thousand seed weight can be chosen for varieties with high yield, as the main selection criteria. In an experiment to verify the percentage oil in 6-safflower crop, it was observed that the percentage varies between 29.20 percent to 34.00 percent among genotypes[9]. The results of variance analysis indicated a significant difference ($P < 0.01$) for all traits among the genotypes. This experiment showed that seed yield per plant is significantly correlated with seed yield per plot, biomass, pod number per plant, a hundred seed weight, the number of secondary branches per plant and oil yield. The results showed a significant correlation among main components of safflower yield; namely the pod per plant, seed at pod and a hundred seed weight, except for pod number per plant that show no correlation with the number of seed per pod. Because the pod count is done easily, the high seed and oil yield selection in safflower can be based on the higher pod number per plant[1].

EXPERIMENTAL

The time and place of experiment

This plan was applied in 2012 – 2013 crop year, at 51 degrees 6 minutes east longitude and 35 degrees 49 minutes north latitude of 1231 m. Table 1 showsthe results of soil test in the site.

Name and characteristics of the cultivars tested

In this experiment, 15 genotypes domestic, foreign and crosses varieties of safflower were tested with their name and morphological characteristics are given in Table 2

Statistical scheme

The experiment is conducted in a randomized complete block design with four replications. The purpose of this experiment was to compare cultivars to find desired cultivarsby seed yield and oil percent. Meanwhile, a number of important agronomic traits were analyzed and the correlation of these traits with seed yield and oil yield is checked.

Land preparation

In order to perform this test, plot of land with dimensions of 15 by 30 m was selected and included plow and disk tillage. Along with tillage, 50 kg per hectare nitrogen fertilizer as urea and 70 kg per hectare phosphorus as superphosphate was added to the soil. To control weeds Terfanocide herbicide with 2 liters concentration per hectare was used; so that the herbicide was spread on the soil before performing and then quickly was mixed with the soil.

Planting

After Land preparation and furrows provision, the landwas divided into four replicates with about 1 meter distance between each repetition. The number of plots in each block is 15. Each plot was planted with 4 lines of 3 m long. Considering the distance of 50 cm between lines grown in each plot, the size of each plot was obtained in 2 ×3 .Seeding density was high and about 25 kg per hectare. It was in the later stages of thinning operations, the appropriate concentration of about 40 to 50 plants per square meter was obtained. After sowing heavy irrigation was performed toprovide sufficient moisture in the soil for seed germination.

Growing

Irrigation was performed in after planting stage, after emergence, stems rapid growth start, budding, flowering, 50% flowering, end of flowering and seeds filling using a siphon leaking irrigation method. Weeding weeds was also performed coinciding with plantation thinning, at this time the plants had 4 to 6 true leaves. To deal with pests, especially safflower fly, pesticide was sprayed at farm at blooming stage by the concentration of about 2.5 per thousand

Harvest

Harvesting began after drying the leaves and pods. In order to study, plants from each plot were selected. Thus, to remove plants from the four existing lines,2 midfielder were used with attempt not to selectplants at the beginning and the end of the lines. Meanwhilepostharvest single plant,the whole plot was harvested using sickle, and then a combine machine adjusted to separate seeds was used.

Trait measurement

Dates' Registration: For date' sregistration, farm was visited at different stages and every stage date was recorded in a sampling form for each step.

Plant height from soil level: The farm was visited at plant maturity stage to measure plant height. Selecting plants, they were cut near the soil surface and using an index measuring stick, the plants height were measured and recordedin the sampling forms.

The height of the first effective branch of the soil surface: After measuring height using an index measuring stick the plants height was measured and recorded in the sampling forms.

The number of effective branches per plant: After the previous two traits measured,the number of branches per plant was counted recorded in the sampling forms. Counting the number of branches per plant, only secondary tributaries were counted and attempts were doneto avoid inclusion of branches that lead to ineffective pods. The number of effective pods per plant:After counting tributaries pod number per plant were counted for each sample and were recorded on the forms. Only effective pods with good appearance were considered andattempts were done to avoid inclusion of ineffective pods , namely too small ones or those with poor appearance or pesticides. Biological yield per plant: Biological yield is the plant yield at maturity including underground organs (roots) and shoots (leaves and other parts out of the soil). Because of the difficulty of measuring

the yield of root, the biological function of shoots is considered to calculate the biological function of plant.

For this purpose, total aboveground plantwas removed fromnear the soil surface andthenwas transferred to stock agency, seedwas weighted using weight scale, and the weight of the plant was regarded as a biological function.The number of seeds per plant: for the measurement of the number of seeds per plant, plant transferred to stock, pods per plant were isolated in separate packet. The pods of each plant were crushed by the machine and its seeds were removed and put the inside the packet. Then the packet is transferred to the laboratory division and seed number per plant was counted using a special machine and the number was recorded.The Number of seeds per pod: After counting the number of seeds per plant, pod number per plant divided the number of seeds and the number of pods per plant was obtained and then was recorded in the sampling form. A thousand seeds weight:After counting the number of seeds per plant, that number of seed was weighted andwith a fit, seed weight per plant was calculated and the resulting values obtained for the samples were recorded on the forms.Seed yield in plant: For measuring the seed, yield in plants seed yield per plant was selected and then was recorded.

Seed yield per hectare

The experimental plots were used to calculate seed yield per hectare, the plots yield were measured after harvest. Then regarding the area of each plot seed yield per hectare was estimated, respectively.

Oil percentage

N.M.R device was used to compute the percentage of oil, for this purpose, 3 g of seed was carefully cleaned and weighed by a precision scale, and thenseeds were poured into a test tube and were placed inside the device. Then entering the seed weight into the computer system, oil percentage readings were recorded.

Oil yield per hectare

yield of oil per hectare is calculated by multiplying the percent oil content and seed yield. The calculated oil yield per hectare obtained was recorded in the samplingform.

Data Analysis

Variance analysis, charting, mapping tables and calculate the mean correlation between these traits was performed by Excel and MSTAT-C software.

RESULTS AND DISCUSSION

Figure 1 and Figure 2 show measured traits of the cultivars. As we know, genotype and environment are two important factors affecting crop yield, in the meantime genotype relates to potential production capacity and environmental factors determine the final application of this amount of potential capacity. Most sources mentioned pod per plant number as the most important factor to explain the high yield crop varieties that is significantly associated with seed yield. There is a significant positive correlation between seed oil percentage and oil yield per hectare. Small seeds are usually having less skin than larger ones, thus, a greater percentage of oil. The bigger the seeds, the more seed skin, and so the ratio of whole seed kernel declines and as a result oil percentage decreases[10].

Both Figures show that Golemehrand Padideh cultivars are the best ones with 3050 and 3059 kg seeds per hectare, respectively. White flower thornless cultivar with 3011 kg of seeds per hectare were placed in a statistics class a; but, it should be noted that this cultivar due to the lack of colorful florets and Padideh cultivar due to thorns could not compete with Golemehr cultivar. Mec-7 cultivar with 31.63 percent, and Mec-248 with 32 percent were the best varieties of the seed oil content. Thorn less white flowers cultivar with 972 kg seeds per hectar, Golemehr cultivar with

Table 1. Results of soil tests in the site

Soil texture	Absorbable Potential	Absorbable Phosphorus	Nitrogen Percent	Percentage organic matter	EC of soil (mmhos)	pH
Clay loam	312	11.3	0.056	0.8	1.65	7.2

878 kg seeds per hectar and Padideh cultivar with 863 kg seeds per hectar had the highest oil yield. Traits such as pod number per plant, biomass, oil yield, seed number per pod, number of branches and height show a significant positive correlation with seed yield per hectar and caused increased seed yield in sawflower yeild. Traits such as pod number per plant, seed at pod, height, biomass and seed yield show significant positive correlation with oil yield. HI shows plant potent in transferring materials from photosynthesis to seeds.A higher index indicates the efficient use of all conditions by the plant in terms of economic production.

Table 2. Name and morphological characteristics of the cultivars tested

Thorn trait	Flower color	Cultivar name	No.
No	Red	117-MEC	1
No	Red	MEC-295	2
Yes	Red	Golemehr	3
No	Red	MEC-184	4
Yes	Red	Goldasht	5
No	White	White thorn less flower	6
No	Red	MEC-11	7
No	Red	MEC-7	8
No	Orange	MEC-10	9
Yes	Orange	MEC-9	10
Yes	Orange	MEC-4	11
Yes	Orange	MEC-26	12
Yes	Orange	MEC-23	13
Yes	Orange	Padideh	14
Yes	Red	MEC-248	15

Table 3 –shows variance data analysis for plant height from soil surface, the number of branches per plant, the number of pods per plant, biological yield per plant, and the number of seeds per pod. As can be seen the number of effective branches per plant has the highest coefficient of variation,while the biological function of the plant is the largest amount of variance.

Table 4 shows variance data analysis of a thousand seed weight, harvest index,oil percentage, seed yield per hectareand oil yield per hectare. As can be seen oil yield per hectare is the highest amount of variance.

Table 5 showsvariance data analysis on the number of days to flowering, the number of days to start flowering, the number of days to 50% flowering, the number of days to end of flowering and the number of number of days to maturity.

Table 3. Variance data analysis table for plant height from soil surface, the number of branches per plant, the number of effective pods per plant, biological yield per plant, the number of seeds per pod

Traits Resources Changes	Degrees of freedom	Plant height from soil surface	The number of branches per plant	The number of capsules per plant	Biological yield per plant (biomass)	Number of seeds per pod
Treatment (Var)	14	410.48**	55.96**	65.71**	5634046.12**	47.410**
block(Rep)	3	53.48ns	3.57ns	15.52 ns	999752.66 ns	36.311*
Error	42	53.56	8.37	8.18	1122686.936	13.549
Coefficient of Variation (C.V.)	-	4.32 þ	22.32	16þ	10.31	14.12

Table 4. Variance data analysis table for a thousand seed weight, harvest index, oil percentage, seed yield per hectare and oil yield per hectare

Traits Resources Changes	Degrees of freedom	Seed weight	Harvest Index	Oil content	Seed yield per Hectare	Oil yield per hectare
Treatment (Var)	14	21.424**	0.002*	0.002**	394432.60**	43527.97**
block(Rep)	3	22.461**	0.001 ns	0.001 ns	13789.66	6850.35 ns
Error	42	2.783	0.001	0.001	85235.63	9473.429
Coefficient of Variation (C.V.)	-	5.43	12.99	6.65	11.11	12.78

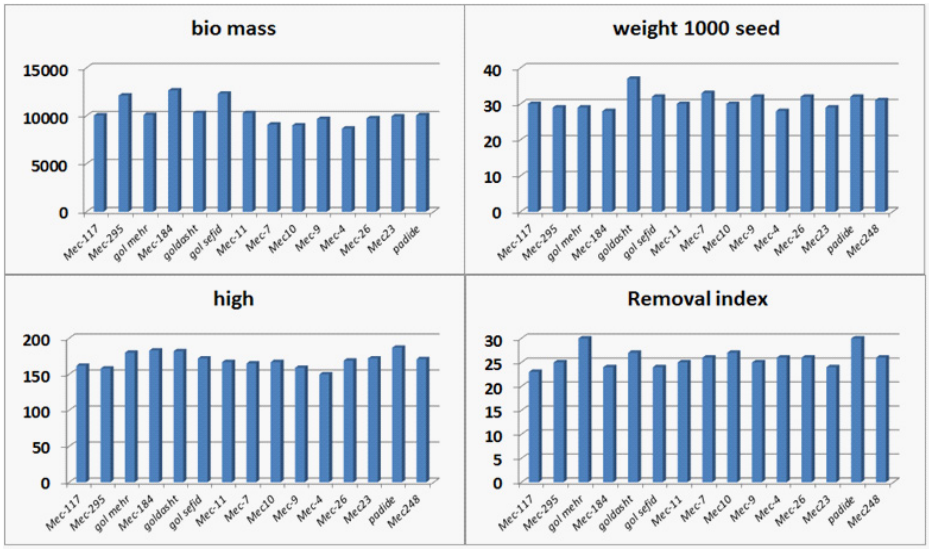

Fig. 1. Safflower samples measured traits including:a thousand seed weight (g), harvest index (%), average plant height (mm) and biological yield (g)

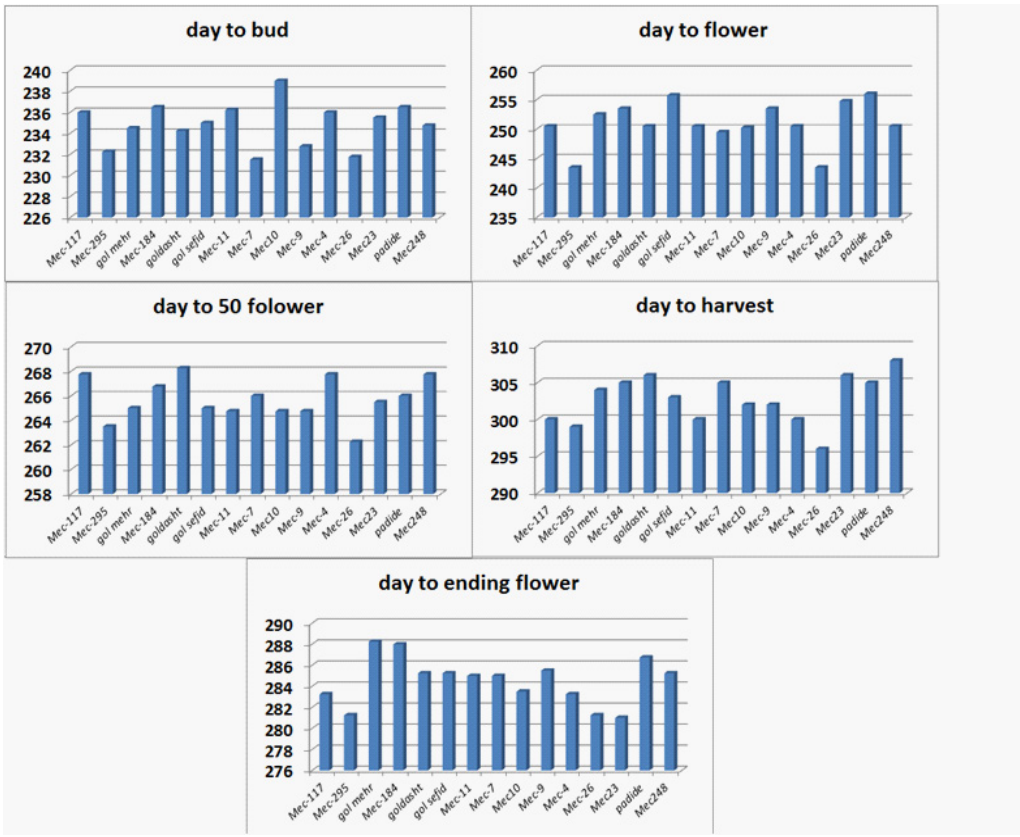

Fig. 2. The number of traits measured for the samples examined including the number of days to budding, the number of days to flowering, the number of days to 50 flowering, the number of days to product, the number of days to the end of flowering

Table 5. Variance data analysis on the number of days to flowering, the number of days to start flowering, the number of days to 50% flowering, the number of days to end of flowering and the number of number of days to maturity

Traits Resources Changes	Degrees of freedom	The number of days to bud	The number of days to flowering	The number of days to 50% flowering	The number of days to End of flowering	Days to maturity
Treatment (Var)	14	7.279 **	11.874 ns	20.686 **	20.567 *	16.600*
block(Rep)	3	ns 2.067	2.867 ns	0.578 ns	1.394 ns	2.906ns
Error	42	3.174	8.474	10.149	11.097	9.013
Coefficient of Variation (C.V.)	-	0.75	1.14	1.21	1.22	1.01

According to the data table, the number of days to 50% flowering is the highest variance.

CONCLUSION

Safflower plants are very expensive in terms of usage. In the survey conducted, Golemehr cultivar with 3050 kg seeds per hectare and Padideh cultivar with 3059 kg seeds per hectare are the best varieties identifiedMoreover, thorn less white flowerscultivar with 3011 kg seeds per hectare were placed at statistical class a.However, it should be noted that this cultivar due to the lack of colorful florets and Padideh cultivar due to thorns could not compete with Golemehr cultivar. Concerning oil content, Mec-7 cultivar with 31.63 percent, and Mec-248 with 32 percent were the best varieties of the seed oil content. oil yield is among the traits that needs special attention. Thorn less white flowerscultivar with 972, Golemehr cultivar with 878 and Padideh cultivar with 863 kg per hectare show the highest oil yield, respectively.

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