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Change in some of soybean seed characteristics in response to leaflet and pod removal treatments

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ABSTRACT

Seed weight is primary component, and an important contributor to soybean yield. For the purpose of better understanding the effects of defoliation treatments on grain characteristics such as effective filling period, grain filling rate, oil and protein content, an experiment was conducted in the research field of the Islamic Azad University of Kermanshah, Iran at 2010. The experimental design was a split plot in randomized complete block with three replications. Main plot treatments consisted cultivars V_1=Williams and V_2=Clark, and Subplot included six treatments of defoliation and pod removal: removing none (T_1), one lateral leaflet at R_1-R_3 (T_2), two lateral leaflets at R_1-R_3 (T_3), one lateral leaflet at R_5-R_6 (T_4), two lateral leaflets at R_5-R_6 (T_5) and pods removal 50% at R_5 +10 days (T_6). The results was shown that there is significant differences among cultivars in oil and protein content ($P<0.01$), and effective filling period ($P<0.05$). Except of oil content, other traits affected by pods and leaflets removal treatments at 0.01 levels, while Interaction effects ($V\times T$) were not significant on all of evaluated traits. Two lateral leaflets removal at R_1-R_3 had the lowest grain filling rate, protein content and grain weight per plant and the longest effective filling period. Oil and protein content in Williams higher than the Clark.

Key word: *Glycine max*, dry weight, grain growth, seed quality, yield components.

INTRODUCTION

Soybean yield can be decomposed in terms of plant stand, pods per node, seeds per pod and seed weight. Therefore, seed weight is primary component an important contributor to soybean yield [5, 23]. Seed weight determined by supply of assimilates during to reproductive growth of plants [10]. Previous studies emphasized that sink strength, depends on two factors: sink size and sink activity. Sink size is the total weight of the sink tissue, and sink activity is the rate of uptake of photosynthates per unit weight of sink tissue [19, 20]. [13] Stated that Seed size is determined by seed filling rate and the effective seed filling period. In addition, crop yield influenced by seed filling rate during the effective filling period [17]. Seed development has been partitioned into three phase: the lag phase that is a period of active cell division and differentiation, the effective grain filling period that is a period of rapid dry matter accumulation, and the maturation phase that this stage, grains lose water and reach physiological maturity [2, 3]. Physiological maturity referred to maximum dry matter accumulation in grains. Seed moisture content reduces in the three phase of seed growth, but this water reduce is the most occur in the third stage [4]**.** [25] Reported that maximize seed weight is achieved at the minimum water content of seed. Defoliation was caused that assimilate availability reduced and seed dry weight in soybean decreased. Reproductive phase in plant affected by hormones that exist in leaves [6], and these hormones determining size and capacity of sink [18], therefore flower production and sink characteristics damages with defoliation occurrence. Studies on the effects of artificial defoliation on soybean were conducted aimed to simulate damages consequent hail, heavy rains, winds, disease and pest. Studies on effects of leaves removal on yield and qualitative traits in crops were shown that defoliation reduces yield and oil content in oilseed crops [1, 8, 15, 16], and degree of decline depended to growth stage of plant [22, 24]. Therefore, The main objectives of this experiment were: (1) to investigate the response of rate and period of seed filling to leaflet and pod removals treatments in different cultivars; and (2) determining effects of these treatments on oil and protein production in soybean.

MATERIALS AND METHODS

A field experiment was conducted in the research field of the Islamic Azad University of Kermanshah province, Iran ($34^0 23'$ N, $47^0 8'$ E; 1351 m elevation). Soybean seeds (cvs. Williams and Clark, maturity groups III and IV, respectively) were sown during 2010 growing season. Seeds were inoculated with Brady*Rhizobium japonicum* and sown at a high-planting rate in field plots. When the unifoliate leaves were expanded, the plots were hand-thinned to obtain a uniform plant population of 33 plants per m^2. The experimental design was a split plot in randomized complete block with three replications. Main plot treatments consisted cultivars V_1=Williams and V_2=Clark, both of which had an indeterminate growth habit and Subplot included six treatments of defoliation and pod removal: removing none (T_1), one lateral leaflet at R_1-R_3 (T_2), two lateral leaflets at R_1-R_3 (T_3), one lateral leaflet at R_5-R_6 (T_4), two lateral leaflets at R_5-R_6 (T_5) and pods removal 50% at R_5 +10 days (T_6). Individual plots were 5 m long and 4.8 m wide (eight rows with 0.60 m between rows). The plots were irrigated when necessary to avoid water deficits. Before sowing, 27 kg of ammonium phosphate (200 kg h^{-1}) and 7 kg of urea (50 kg h^{-1}) were applied and mixed with soil. Phonological stages were defined according to [12]. Soybean cultivars were sown at May 14 and the emergence date was May 26. Beginning bloom (R_1), beginning pod set (R_3), seed enlargement (R_5), and full maturity (R_8) occurred at 47, 56, 79 and 128 day after emergence (DAE), respectively, for Williams and at 51, 63, 87 and 134 DEA, respectively, for Clark. Pods and seeds sampled from the beginning pod set (R_3) up to full maturity (R_8) for each cultivar, separately. The grain filling rate and effective filling period were measured according to [20]. At the end of growth season, ten plants were selected randomly from each plot and oil and protein content were determined according to [7, 26, 27]. Data for evaluated traits were statistically analyzed using a standard analysis of Variance technique for the spit plot in randomized complete block design using the statistical software MSTATC. Means were separated by the Least Significance Difference Test (LSD) at 5 percent probability level.

RESULTS AND DISCUSSION

There is significant differences among cultivars in oil and protein content ($P<0.01$), and effective filling period ($P<0.05$), and had not significant effects on grain filling rate. Statistical analysis showed that, except of oil content other traits affected by pod and leaf removals treatments at 0.01 levels, while Interaction effects (V×T) were not significant on all of evaluated traits (Table

1). Comparison of means was shown that effective filling period in the Clark cultivar with 29.4 (day) were higher than the Williams with 28.6 (day) (Fig 1). In contrast, oil and protein content in Williams higher than the Clark. Williams with 160.5 g/kg and 367.9 g/kg had the most oil and protein content, respectively. The results of (Fig 2) were shown that there were significant differences between effective filling period, grain filling rate, and protein content in leaflet and pod removal treatments.

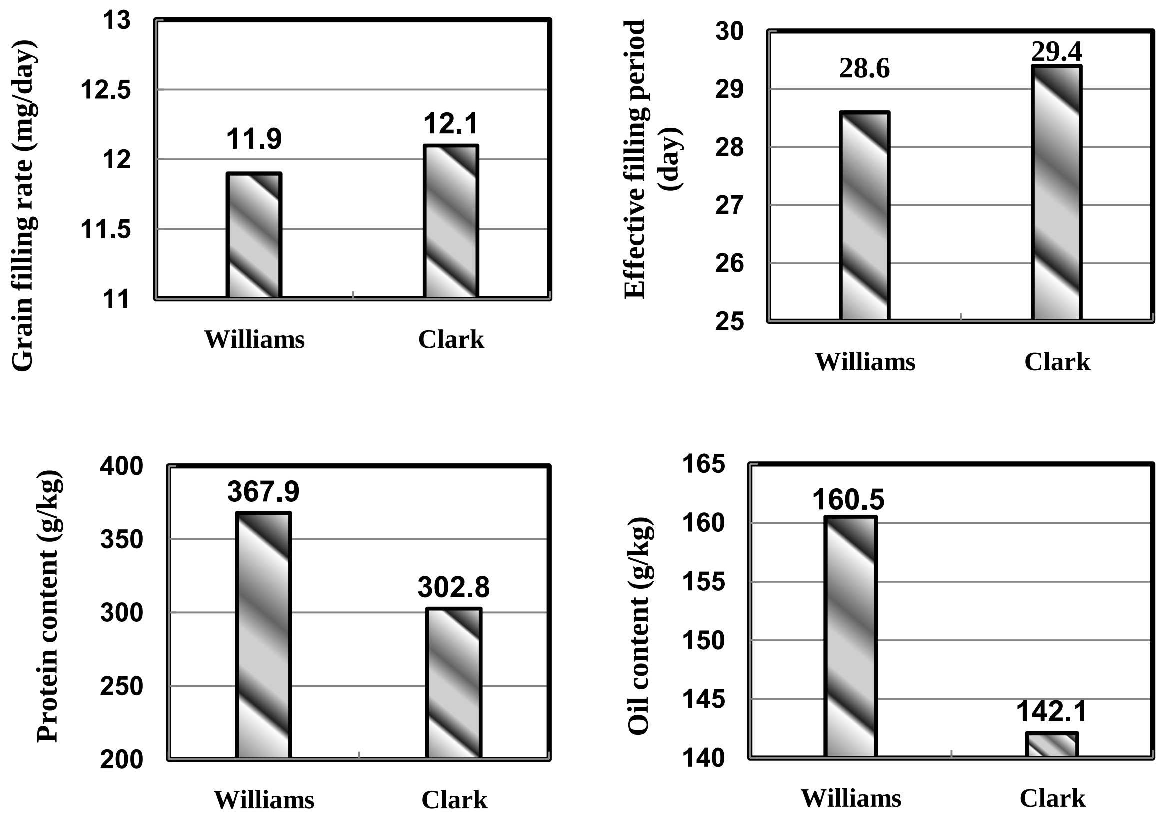

Figure 1. Evaluation of effective filling period, grain filling rate, oil and protein content in two cultivars of soybean.

Table1. Analysis of variance of effective filling period, grain filling rate, oil and protein content in soybean seed

Source of variation	d.f	Ms			
		Effective filling period	Grain filling rate	Oil Production	Protein Production
Block	2	0.259	0.079	2.53	417.59
Cultivar (V)	1	6.233^{*}	0.160^{ns}	3080.250^{**}	38128.42^{**}
Error a	2	0.222	0.235	1.582	358.57
Defoliation (T)	5	28.228^{**}	20.698^{**}	54.294^{ns}	12473.19^{**}
(V)× (T)	5	0.006^{ns}	0.017^{ns}	12.251^{ns}	329.84^{ns}
Error b	20	2.444	0.498	145.323	611.64
Coefficient of variation (%)	-	5.37	5.85	7.97	7.37

*-ns, * and **: non-significant, significant at 5% and 1% levels of probability, respectively*

Figure 2. Evaluation of effective filling period, grain filling rate, oil and protein content in leaflet and pod removal treatments in soybean. T_1, T_2, T_3, T_4, T_5, and T_6: removing none, one lateral leaflet at R_1-R_3, two lateral leaflet at R_1-R_3, one lateral leaflet at R_5-R_6, two lateral leaflet at R_5-R_6, and pod removal 50% at R_5 +10 days, respectively.

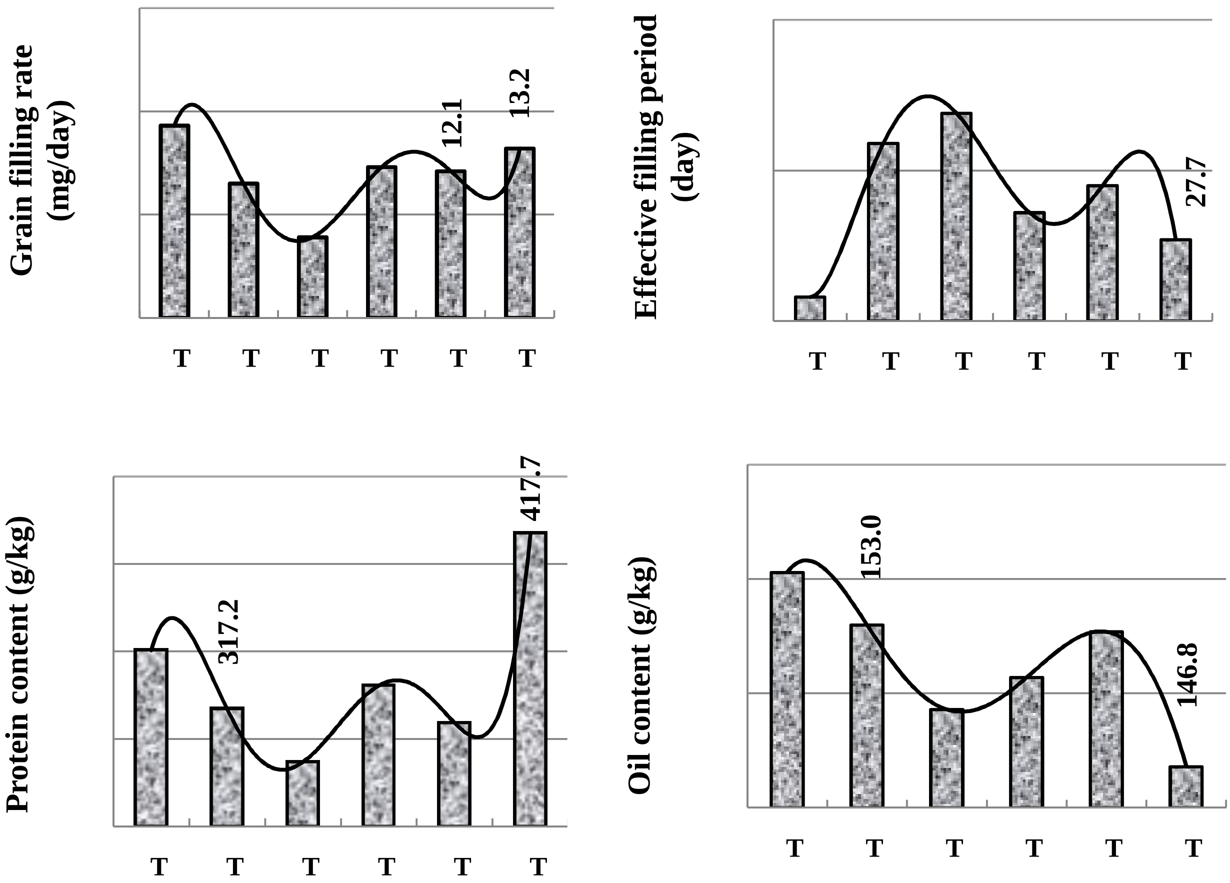

Table 2. Mean comparison of effective filling period, grain filling rate, oil and protein content in soybean according to LSD test in %5 levels

Treatment Interaction V) T)	Means: Effective filling period (day)	Grain filling rate (mg/day)	Oil content (g/kg)	Protein content (g/kg)
V_1T_1	25.5 f	14.3 ab	166.0 a	387.4 bc
V_1T_2	30.5 abc	11.3 e	164.0 ab	348.6 cde
V_1T_3	31.5 ab	8.8 f	158.3 abc	321.5 ef
V_1T_4	28.1 cdef	12.3 cde	158.3 abc	371.8 bcd
V_1T_5	29.1 bcd	12.0 de	160.3 abc	341.4 de
V_1T_6	27.3 def	13.2 bc	156.3 abcd	436.9 a
V_2T_1	26.4 ef	14.5 a	144.7 bcd	314.0 efg
V_2T_2	31.4 ab	11.6 e	142.0 cd	285.9 fgh
V_2T_3	32.3 a	8.9 f	140.3 cd	252.3 h
V_2T_4	29.0 bcde	12.4 cde	143.0 cd	289.4 fgh
V_2T_5	29.8 abcd	12.2 cde	145.0 bcd	277.0 gh
V_2T_6	28.2 cdef	13.2 bcd	137.3 d	398.4 ab

-Similar letters in each column shows non-significant difference according to LSD test in %5 level
-V_1: Williams, V_2: Clark; T_1, T_2, T_3, T_4, T_5, and T_6: removing none, one lateral leaflet at R_1-R_3, two lateral leaflet at R_1-R_3, one lateral leaflet at R_5-R_6, two lateral leaflet at R_5-R_6, and pod removal 50% at R_5 +10 days, respectively.

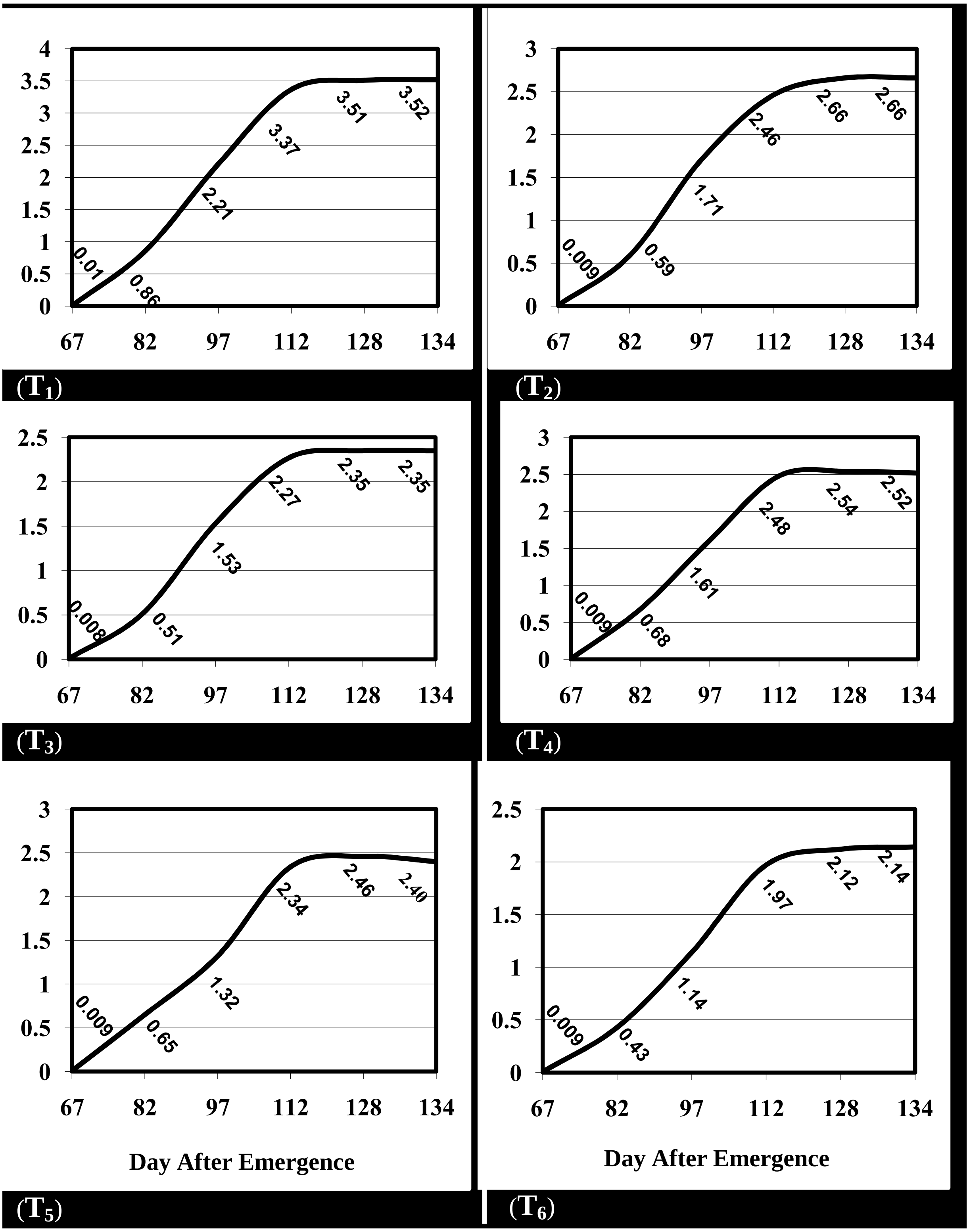

Figure 3. The effects of pod and leaflet removal treatments on trend of grain dry matter accumulation (g/plant).
-(T_1): non removal, (T_2): one lateral leaflet at R_1-R_3, (T_3): two lateral leaflets at R_1-R_3, (T_4): one lateral leaflet at R_5-R_6, (T_5): two lateral leaflets at R_5-R_6, and (T_6): pods removal 50% at R_5 +10 days.

The check treatment with 25.8 day had lower effective filling period, and with 14.3 mg/day had the most grain filling rate than the other treatments. Among the leaflet and pod removal treatments, two lateral leaflets at R_1-R_3 (T_3) treatment had the lower grain filling rate and protein content with 8.9 mg/day and 286.9 g/kg, respectively. In addition, T_3 treatment had the longest effective filling period, otherwise, the lowest of grain weight compared with other leaflet removal treatments was observed in T_3 (Fig 3). Reduce in assimilate availability due to defoliation and/or shading occurred and causes decrease in grain filling rate and increase in effective filling period in soybean plant [9].

Table 3. Regression equation and coefficient of determination (r^2) changes of seed dry weight in pod and leaflet removal treatments

Defoliation treatments	Equation	r^2
T_1	$GDW=-0.610+0.236X+0.387X^2-0.052X^3$	0.991
T_2	$GDW=-0.479+0.164X+0.308X^2-0.042X^3$	0.979
T_3	$GDW=-0.362+0.590X+0.302X^2-0.040X^3$	0.985
T_4	$GDW=-0.699+0.568X+0.154X^2-0.027X^3$	0.993
T_5	$GDW=-0.332+0.127X+0.266X^2-0.035X^3$	0.986
T_6	$GDW=-0.015-0.314X+0.361X^2-0.042X^3$	0.992

-All equation were statistically significant for P=0.05. Where GDW is grain dry weight, and X is day after emergence.

-(T_1): non removal, (T_2): one lateral leaflet at R_1-R_3, (T_3): two lateral leaflets at R_1-R_3, (T_4): one lateral leaflet at R_5-R_6, (T_5): two lateral leaflets at R_5-R_6, and (T_6): pods removal 50% at R_5 +10 days.

These results were shown that, there is a positive correlation between grain filling rate and final grain weight, and there is a negative correlation between effective filling period and seed weight. [14] Reported that grain filling rate in soybean, rather than filling duration, was positively correlated with seed weight. There is competition among growing grains due to source-limited during grain filling period [21]. In addition, the lowest oil content belonged to pods removal 50% at R_5 +10 days treatment (Fig 2). Interaction effects between treatments was shown that among V_2T_3 and V_1T_1 with 32.3 and 25.5 day had the highest and lowest effective filling period, respectively. While, V_2T_1 and V_2T_3 with 14.5 and 8.9 mg/day had the highest and lowest grain filling rate, respectively (Table 2). Application of T_6 treatment in Williams cultivar was caused that protein content increased up to 436.9 g/kg. The highest oil content was observed in the check treatment with 166 g/kg. This result agrees with previous findings [8, 15, 16].

[1] Emphasized that quantity and quality traits in crops affected by leaves removal and defoliation reduces yield and oil content in oilseed crops. There is a negative correlated between oil and protein content and increases in protein coincided to oil decreasing. Results of this study was shown that pods removal 50% at R_5 +10 days in Clark reduces oil content in soybean grain up to 137.3 g/kg (Table 2). The effects of leaflet and pod removal treatments on dry matter accumulation are shown in (Fig 3). These results indicated that pod and leaf removal treatment can strongly influence grain dry matter accumulation in soybean, which ultimately affected grain weight. The best regression equation and coefficient of determination for simulate trend of changes in pod and leaflet removal treatments was shown in Table 3. The grain growth had a sigmoid chart, Therefore, at first dry matter accumulation increases lightly, and then, trend of changes in dry weight in grain was accelerate, in all of treatments from T_1 to T_6 this occurred at 82 days after emergence, approximately. In addition, from 112 day after emergence trend of changes in dry matter accumulation in grain was decreased up to full maturity. In present study, T3 treatment (two lateral leaflets at R_1-R_3) had the lowest in both grain filling rate and grain dry weight compared with the other leaflet removal treatments. This results according to previous findings [11, 25].

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REFERENCES

[1]-Abdi, S., Moghaddam, A., and Ghadimzadeh, M, *J. Sci. Tech. Agric. Nat. Resources*, **2007**, 11 (40): 245-255.
[2]-Beweley, J. D., and Black, M, *Seeds: Physiology of development and germination*, Plenum, New York, **1985**.
[3]-Borras, L., and Westgate, M. E, *Field Crops Res*, **2006**, 95: 223-233.
[4]-Borras, L., Westgate, M. E., and Otegui, M. E**,** *Ann. Bot*, **2003**, 91: 875-867.
[5]- Borras, L., Slafer, G. A. & Otegui, M. E, *Field Crops Res*, **2004**, 86, 131–146.
[6]-Coleman, R. E. *Some aspects of flowering stimulus production in sugarcane*, Proceedings of International Society Sugar Cane Technology, **1967**, 12: 813-818.
[7]-Dardanelli, J. L., Balzarini, M., Martinez, M. J., Cuniberti, M., Resnik, S., Ramunda, S. F., Herrero, R., and Baigorri, H, *Crop Sci*, **2006**, 47: 1939-1947.
[8]-De Beer, J. P, *Crop. Pro*, **1983**, 12: 110-112.
[9]- Egli D.B., Bruening W.P, *Ann. Bot*, **2001**, 88: 235–242.
[10]-Egli, D. B., Bruening, W. P, *European. J. Agron*, **2006**, 24: 11-18.
[11]-Egli, D. B., Fraser, J., Leggett, J. E., and Poneleit. C. G, *Ann. Bot*, **1981**, 48: 171-176.
[12]-Fehr, W.R., and C.E. Caviness. *Stages of soybean development*.Spec, Rep, Iowa State Univ, Ames**, 1977**, 80,
[13]-Gbikpi, P.J., and R.K. Crookston, *Crop sci*, **1981**, 21:652-655.
[14]-Guldan, S. J., and Brun, W. A, *Crop Sci*, **1985**, 25: 815-819.
[15]-Johnson, B. J, *Agron. J*, **1972**, 64: 688-689.
[16]-Johnson, B. J, *Can. J. Plant. Sci*, **2003**, 83: 319-326.
[17]-Kaplan, S.L.and H.R Kooler, *Crop sci*, **1974**, 14:613-614.
[18]-Liu, X. B, *Crops Res*., **1993**, 3: 33-35, (In Chinese).
[19]-Liu, X., and Herbert, S. J, *J. Northeast Agric Univ*, (Engl. ed.), **2000**, 7: 171-178.
[20]-Liu, X., S. J. Herbert,. Baath, K., Hashemi, A. M, *Plant Soil Environ*, **2006**, 52 (4), 178-185.
[21]-Miralles, D. J., Slafer, G. A, *Field Crops Res*, **1995**, 43: 55-66.
[22]-Pettroff, R, *Sunflower production in Montana*. Montana State University, USA, **2002**, PP 182.
[23]-Quijano, A., and Morandi, E. N, *Field Crops Res*, **2011**, 120: 151-160.
[24]-Schneiter, A., Jones, J. M., and Hammond, J. J, *Agron. J*, **1987**, 79: 431-434.
[25]-Swank J.C., Egli D.B., Pfeiffler T.W, *Crop Sci*, **1987**, *27*: 85–89.
[26]-Wilcox, J. R., and Shibles, R. M, *Crop Sci*, **2001**, 41: 11-14.
[27]-Zhong, W, *Determination of the total lipids in plants, In Xue Y., Xia Z., eds. Laboratory Manual of Plant Physiology*. Shanghai Science and Technology Press, **1985**, 198-201.