International Journal of Scientific Engineering and Science
Volume 4, Issue 12, pp. 1-5, 2020. ISSN (Online): 2456-7361

Evaluate the Performance of Early Set Soybean (Glycine max (L) Merrill) Varieties under Irrigation in North Western Ethiopia

Molla Malede*, Asmamaw Amogne, Derese Hunde
Ethiopian Institute of Agricultural Research, Pawe Agricultural Research Center, P. O. Box 25, Pawe, Ethiopia
Corresponding author: maledemolla @ gmail.com

Abstract**—** *This experiment was conducted in 2018 and 2019 off seasons at Pawe Agricultural Research Center irrigation site of Duhuans Baguna substation, to select high yielder and best performing soybean varieties under irrigation, to generate information about the varietal performance and widen the production options to investors and smallholder farmers in addition to rainfed. The experiment consisting eight early set soybean varieties and was done using randomized complete block design with three replications. The result revealed that there was highly significant difference in days to flowering, 100 seed weight and grain yield among the tested varieties. The variety was significantly interacted with year in days to flowering, grain yield, plant height, numbers of branches, and 100 seed weight. Two-year combined results of grain yield were ranged from 1147.7 to 2479.8 kg ha^{-1}. The highest grain yield was found by Coker-240 (24.79.8 kg ha^{-1}) followed by Gozela (2293.9 kg ha^{-1}) and Awassa-95 (2286.2 kg ha^{-1}) whereas Nova (1147.7 kg ha^{-1}) and William (1343.3 kg ha^{-1}) were recorded the lowest grain yield, respectively. Therefore, the variety Coker-240, Gozela and Awassa-95 are recommended for production under irrigation environmental conditions in northwestern Ethiopia and similar agricultural ecologies*.

Keywords**—** *Grain Yield, Irrigation, Performance, Production, Soybean Variety*.

I. INTRODUCTION

Irrigation has been tremendously refreshing for its noteworthy commitment to worldwide farming production and food security in the course of recent years. Now a day, greater than 40 percent of worldwide agricultural products are created on irrigated land (FAO, 2018). To meet the food necessities of the total populace, food creation should be expanded by 70 percent all around and by 100 percent in creating developing nations, and irrigation system is relied upon to be a significant giver (FAO, 2012a).

In Africa, Agriculture represents about portion of the landmass' total national output and utilizes 60 percent of the work power (FAO/IFC Cooperation, 2015). In any case, current irrigation system frameworks assume a restricted job specially in eastern Africa's agriculture. Nourishment creation in the district remains to a great extent rely upon rainfed and just 2.8% of the all-out developed region is irrigated (FAO Aqua detail, 2016). Both irrigated and rainfed agriculture are significant in the Ethiopian economy. Be that as it may, 97% of all food crops originate from rainfed farming (FAO/IFC Cooperation, 2015), which implies a noteworthy bit of developed land isn't irrigated (Awulachew *et al.*, 2010).

Ethiopia has huge water assets. As of now, the MoWR (Ministry of Water Resources) has distinguished 560 irrigation potential destinations on the significant river basins. Ethiopia has 12 river basins that give an expected yearly overflow of ~125 billion m3, with the Abbay basins (in focal and northwest Ethiopia) representing ~45 percent of this sum. Nonetheless, Ethiopia has constrained irrigation framework to utilize this surface water (Awulachew *et al.*, 2010).

The absolute potential irrigable land in Ethiopia is evaluated to be around 3.7 million hectares. In the nation, customary traditional irrigation system was practiced before hundreds of years (Bekele *et al*., 2012). Be that as it may, modern irrigation frameworks were begun during the 1960s with the target of creating modern yields in Awash Valley. Privately owned businesses worked ranches for developing business harvests, for example, cotton, sugarcane and plant crops began the principal formal water system plots in the late 1950s in the upper and lower Awash Valley (Awulachew *et al*., 2007).

Soybean (Glycine max L.) positions first among oilseed crops on the planet and it contributes almost 25 percent of universes all out oil and fat production (Basediya *et al.*, 2018). The world soybean yearly production is represented 362.87 million metric tons. Top five world soybean delivering nations are USA, Brazil, Argentina, China and India, which represent 89.31% of world stockpile (USDA, 2019).

In Ethiopia, Soybeans is delivered on more than 64,720.12 ha yearly with national normal yield of 23.09 tons ha^{-1} (CSA, 2019). The significant soybean delivering zones are North Western and South Western parts of the nation, for example, Amhara, Benishangul Gumuz, and pieces of Oromia region which account 99.6% of production.

There are fundamental constraints in Ethiopia that is impacted the distribution, production and soybean usage generally the nation over. Among these issues, absence of irrigation facilities, restricted mindfulness about the dietary benefit of the crop and food planning, and absence of genetic diversity are taking the lions share. There is yield gap of soybean production at research and farmers' fields, generally came about because of use of improper agricultural inputs, harm by biotic and abiotic stresses, constrained accessibility of seed and restricted commonality with the variety, constrained utilization of current agronomic practices and poor extension services (Atnaf *et al*., 2015).

Beforehand, a large portion of the released soybean varieties by the national and regional research establishment were tried fundamentally for rainfed developing conditions. In this manner, the present investigation was led to choose high yielder and best performing soybean varieties under irrigation condition, to create data about the varietal execution and enlarge the creation alternatives to investors and smallholder farmers notwithstanding rainfed agriculture.

II. MATERIALS AND METHODS

Experimental Site and Conditions

The present study was conducted during the 2018 and 2019 winter seasons at Pawe Agricultural Research Center irrigation site, Duhuans Baguna substation which is located in Benishangul Gumuz Regional State in Metekel Zone. Experiment location was 1190 m above sea level and it was situated within 11.06°, 02´ N latitude and 36.32°, 13´ E longitude. The soil textural class was a clay loam with 38% clay, 24% silt and 38% sand at 30cm soil depth.

Experimental Material

Eight early maturing released soybean varieties were used for this study. These materials were released by federal and regional agricultural research institute in our country. The lists of materials used for this experiment are preset in Table 1 below.

Experimental Design and Cultural Practices

The experiment was arranged in a randomized completely block design with three replicates. Each variety was planted using 2.4 m × 4m plot area and 100kg ha^{-1} DAP which applied at sowing. The two-year experiments were sown on 15 and 11^{th} of December for 2018 and 2019 seasons, respectively.

The experiment was performed by furrow irrigation with spacing of 40cm between rows and 15cm raising bed. Soybean seeds were planted in spaced 5cm between plants on the one shady sides of the ridge, to protect them from the sun. The plots were irrigated using a conventional furrow irrigation method at 100% FC (field capacity) and subsequent irrigations were applied every 9 days during plant vegetative development stage, and every 7 days during reproductive stages up (R7 = Beginning maturity) one normal pod on the main stem that has reached its mature pod color.

Data Collection

The phenological, yield and yield contributed trite data were recorded. At maturity, five plants were randomly selected from the two central rows of each plot and the following traits were measured; plant height (cm), number of branches $plant^{-1}$, number of pods $plant^{-1}$, number of seeds $plant^{-1}$ and number of seeds pod^{-1}. Seed yield kg ha^{-1} was calculated over all plants in the two central rows of the plot.

Statistical Analyses

The two consecutive years, phenological, yield and yield contributing traits data were recorded. The results of those data were subjected to Analysis of Variance test using the general linear model (GLM) in SAS 9.4 software. The least significant difference (LSD) test at 5% of probability was performed to compared the differences among the varieties. Data for the two years was tested for homogeneity of variance using Levene's test of homogeneity and it was found to be homogeneous, so the data were combined for further analysis.

Table 1: List of released soybean varieties, year of released and released institute

S.no.	Variety	Maturity group	Year of released	Released center
1	Jallele	Early set	2003	Awassa ARC/SARI
2	Hawassa-04	Early set	2012	Awassa ARC/SARI
3	Nyala	Early set	2014	Pawe ARC/EIAR and AwARC
4	Gozela	Early set	2015	Pawe ARC/EIAR and AwARC
5	Nova	Early set	2012	Awassa ARC/SARI
6	Cocker-240	Early set	1982	Awassa ARC/SARI
7	Awassa-95	Early set	2005	Awassa ARC/SARI
8	Williams	Early set	-----	Awassa ARC/SARI

Where ARC= Agricultural Research Center, AwARC= Awassa Agricultural Research Center, EIAR = Ethiopian Institute of Agricultural Research, ARARI=Amhara Regional Agriculture Research Institute, OARI= Oromia Agriculture Research Institute and SARI= Southern Agriculture Research Institute

III. RESULTS AND DISCUSSION

Combined Analysis of Variance (Anova)

Leven's test result revealed that error variance was homogeneous for grain yield, hundred seed weight, days to maturity and flowering, numbers of branches and plant height in two consecutive years (appendix Table 1) and allowed to proceed for further analysis of variance across two years.

Combined analysis of variance was done for traits having homogenous error variances (appendix Table 1). The mean square values are presented in (Table 2). The analysis of variance showed that there was statistically highly significant difference in years for traits, days to flowering and maturity, numbers of pods and seed $plant^{-1}$, and grain yield. This may indicate, those variety was significantly influenced by the environment. Similar findings reported on plan height (Perez Arocho, 2017), grain yield, days to flowering and maturity, number of pods plant-1 and plant height (Ibrahim *et al*., 2017). Similarly, there was highly significant difference in days to flowering, 100 seed weight and grain yield and significant on days to maturity among varieties. These indicates the presence of genetic variability among the variety on those traits. These finding is in line with (Perez Arocho, 2017) who reported that there was highly significant variation among tested soybean population under irrigation on those Traits. The variety interaction with year had high significant on trait days to flowering and grain yield and significant on plant height, numbers of branches, and 100 seed weight. The present study is comparable with the previous finding on traits days to maturity, plant height, and 100 seed weight (Ibrahim *et al*., 2017)

Table 2: Combined analysis of variance for 9 agronomic traits of 8 early set soybean varieties evaluated under irrigation in two consecutive seasons of 2018 and 2019

Trait	Year df=1	Rep(year) df=4	TRT df=7	Year*TRT df=7	Error Df=28	CV %
DF	1912.69**	0.5^{ns}	343.57**	28.45**	1.71	2.73
DM	9380.02**	5.04^{ns}	453.31*	66.69^{ns}	111.83	10.15
PH	64.17^{ns}	100.61^{ns}	229.19^{ns}	331.63*	102.77	17.64
PPP	4570.80**	21.08^{ns}	99.46^{ns}	58.76^{ns}	62.07	24.77
SdPP	19416.61**	217.20^{ns}	169.73^{ns}	191.50^{ns}	228.12	26.70
SdP	0.22^{ns}	0.05^{ns}	0.19^{ns}	0.24^{ns}	0.14	20.81
NB	0.56^{ns}	2.05^{ns}	3.51*	3.20*	1.23	30.06
HSW	5.01^{ns}	6.67^{ns}	32.12**	9.23*	3.42	12.16
GY	6044060.69**	154654.86ns	1324472.89**	663717.86**	131623.32	18.89

Where DF= days to 50% flowering, DM= days to maturity, PH= plant height(cm), PPP= number of pods plant^{-1}, SdPP= number of seeds plant^{-1}, SdP= number of seeds pod^{-1}, NB= number of branch plant^{-1}, HSW= 100 seed weight(gm), and GY = grain yield (kg ha^{-1})

Agronomic Performance of Varieties

Grain yield was ranged from 594.2 to 2717.1 kg ha^{-1} in 2018 and 1701.1 to 2918.7 kg ha^{-1} in 2019, respectively (Table 3 and 4). In 2018, the highest grain yield was found in variety Awassa-95 (2717.1 kg ha^{-1}) , Coker-240 (2041 kg ha^{-1}) and Gozela (1839.5 kg ha^{-1}) whereas the lowest grain yield was found in variety Nova (594.2 kg ha^{-1})) and William (925 kg ha^{-1}), respectively. In 2019 season, the highest grain yield was found in variety Coker-240 (2918.7 kg ha^{-1}), Gozela (2748.4 kg ha^{-1}) Jallele (2505.5 kg ha^{-1}) and Nyala (2489.6 kg ha^{-1}) whereas the lowest grain yield was found in variety Nova (1701.1 kg ha^{-1})) and William (1761.7 kg ha^{-1}), respectively (Table 3 and 4).

The combined result confirmed that there was significant variation in grain yield among the varieties. The variation might be due to the different in genetic background of these varieties and their response to irrigation environment. Two consecutive year combined grain yield was ranged from 1147.7 to 2479.8 kg ha^{-1} (Table 5). The highest grain yield was found by the variety Coker-240 followed by Gozela and Awassa-95 whereas the lowest grain yield (kg ha^{-1}) was recorded on variety Nova (1147.7) and William (1343.3 kg ha^{-1}), respectively (Table 5). The varieties Gozela, Awassa-95, and Jallele were produced relatively similar grain yield 2293.9, 2286.2 2067.8, kg ha^{-1} respectively.

Days to flowering were ranged from 39.33 to 70 days at 2018 experimental season. Variety Nova, Hwassa-04 and Gozela were flowered early, while Coker-240 and Jallele were flowered late (Table 3). In 2019, days to flowering were ranged from 34.67 to 59 days. Variety Nova, Nyala and William were flowered early, while Coker-240 and Hwassa-04 were flowering late (Table 4). The overall combined result revealed that days to flowering ranged from 37 to 64 days. The variety Nova was flower extra early while Coker-240 was flower lately (Table 5).

Days to maturity of varieties were ranged from 104 to 132 days at 2018 experimental season. Varieties William and Awassa-95 were matured early, while Coker-240, Nyala and Jallele were matured late (Table 3). In 2019, days to maturity of genotypes were ranged from 83 to 112.33 days. The varieties William, Nova and Awassa-95 were matured early, whereas Coker-240 was matured late (Table 4). The interesting finding in this study there is cross over interaction on varieties Jallele and Nova in days to maturity, which indicate the season had significant influence on days to maturity of this two varieties. The combined result revealed that days to maturity ranged from 93.5 to 122.2 days (Table 5). The variety William, and Awassa-95 were matured early while Coker-240 was matured late.

The mean performance of pods number plant^{-1} in 2018 and 2019 is presented in Table 3 and 4 respectively. The number of pods plant^{-1} of varieties was ranged from 19.33 for variety William to 26.33 for Hawass-04 in 2018 (Table 3), while from 32.13 for variety Coker-240 to 51.8 for variety Jallele in 2019 experimental season (Table 4). The performance of pods plant^{-1} was relatively good in 2019 season. The experiment was damaged by mice specially in 2018 cropping season (20-30%) of pods, Since the experiment was done during dry and hot season which alternative hosts not available for mice.

In 2018, Plant height at maturity among tested soybean varieties, William was produced tallest plants of 68.33 cm followed by Coker-240 (59 cm), while plant height was shortest in both Hawassa-04 (45.73 cm) and Jallele (51.2 cm) (Table 3). In 2019, longest plant height was recorded on varieties Gozela (73.63cm), Hawassa-04 (71.43cm) and Coker-240 (70.1cm), while shortest plant height found on varieties Nyala (41.53cm), followed by Awassa-95 (45.67cm) (Table 4).

There was variation in plant height among the tested soybean varieties in season. The variation may be occurred due to seasonal variation (genotype by environment interaction). The combined mean performance in plant height revealed that there was no significant difference among the tested varieties. The tallest plant height recorded by varieties Gozela (65.1cm) followed by coker-240 (64.53cm) and William (62.63cm) (Table 5).

Hundred seed weight (g): the single as well as the combined mean comparison results revealed that there was significant variation in hundred seed weight among the tested soybean varieties. The difference might be due to the difference in genetic constitution of the varieties and response to irrigation environmental. Hundred seed weight ranged from 12.5g to 19.5g in 2018, from 12.67g to 19.83g in 2019 and from 12.83 to 19.67g in two-year combined means, respectively (Table 3, 4, and 5).

Table 3. Mean performance of Released soybean variety Early Set Evaluated under irrigation in 2018

Variety	GY (kg ha^{-1})	DF	DM	PH	PPP	SdP	NB	HSW
Jallele	1630	57	124	51.2	24.2	1.52	3.33	17.17
Ags-71	1587.3	52	118.67	45.73	26.33	1.82	3.67	16
Nyala	1186.4	55	124	57.4	22.53	1.61	2	19.5
Gozela	1839.5	52.67	116.33	56.53	20.6	1.64	3.67	12.5
Nova	594.2	39.33	118.67	57	23.4	1.26	3.67	12.83
Coker-240	2041	70	132	59	19.87	1.79	4	14.5
Awassa-95	2717.1	54.67	107.67	55.33	20.13	2.06	3.67	13.67
William	925	54.33	104	68.33	19.33	2.14	4.67	13
Mean	1565.01	54.38	118.17	56.32	22.05	1.73	3.58	14.9
CV%	25.79	1.49	12.56	17.51	28.53	27.89	27.57	9.03
LSD (0.05)	706.95*	1.398*	25.99	17.27	11.02	0.85	1.73	2.36*

Table 4. Mean performance of Released soybean variety Early Set Evaluated in 2019 under irrigation

Variety	GY (kg ha^{-1})	DF	DM	PH	PPP	SdP	NB	HSW
Jallele	2505.5	40	89	56.27	51.8	1.71	3	16.67
Ags-71	2217.9	43.33	88	71.47	42.33	1.63	5.47	15.5
Nyala	2489.6	38.33	89.67	41.53	36.53	1.84	3.07	19.83
Gozela	2748.4	40	92.33	73.63	37.47	1.73	6.2	19.17
Nova	1701.1	34.67	83	53.47	44.53	2.08	3.67	13.33
Coker-240	2918.7	59	112.33	70.07	32.13	2.30	3.2	13.5
Awassa-95	1855.4	38.33	84.33	45.67	49.8	1.60	2.93	13.67
William	1761.7	40.33	83	56.93	37.93	2.03	2.87	12.67
Mean	2274.78	41.75	90.21	58.63	41.57	1.87	3.8	15.54
CV%	13.92	4	2.03	17.75	22.13	11.63	32.09	14.44
LSD (0.05)	554.56*	2.93**	3.21**	18.23*	16.11	0.38*	2.14*	3.93*

Where DF= days to 50% flowering, DM= days to maturity, PH= plant height(cm), PPP= number of pods plant^{-1}, SdP= number of seeds pod^{-1}, NB= number of branch plant^{-1}, HSW= 100 seed weight(gm), and GY = grain yield(kg ha^{-1})

Mean values of the data indicated that greater hundred seed weight was recorded with Nyala (19.5), Jallele (17.17g) and Hawassa-04 (16g) in 2018, Nyala (19.83g), Gozela (19.17g) and Jallele (16.67g) in 2019, which was statistically similar (Table 3 and 4). Based on the overall mean performance, the highest hundred seed weight was recorded with variety Nyala (19.67g) followed by Jallele (16.92g), while the lowest weight was found with variety William (12.83g) and Nova (13.1g) respectively, (Table 5).

Table 5. Combined Mean Performance of 8 early set soybean varieties evaluated at Duhuans Baguna substation irrigation site in two consecutive years 2018 and 2019.

Variety	GY (kg ha-1)	HSW	NB	PH	DM	DF
Jallele	2067.8	16.92	3.17	53.73	106.5	48.5
Ags-71	1902.6	15.75	4.57	58.6	103.33	47.67
Nyala	1838	19.67	2.53	49.47	106.83	46.67
Gozela	2293.9	15.83	4.93	65.08	104.33	46.33
Nova	1147.7	13.08	3.67	55.23	100.83	37
Coker-240	2479.8	14	3.6	64.53	122.17	64.5
Awassa-95	2286.2	13.67	3.3	50.5	96	46.5
William	1343.3	12.83	3.77	62.63	93.5	47.33
Mean	1919.93	15.22	3.69	57.47	104.19	48.06
CV%	18.89	12.16	30.06	17.64	10.15	2.73
LSD (0.05)	429.06*	2.19*	1.31*	11.99	12.51*	1.55*

Where DF= days to 50% flowering, DM= days to maturity, PH= plant height(cm), PPP= number of pods plant^{-1}, SdPP= number of seeds plant^{-1}, SdP= number of seeds pod^{-1}, NB= number of branch plant^{-1}, HSW= 100 seed weight(gm), and GY = grain yield (kg ha^{-1}).

IV. CONCLUSION

This experiment was done in 2018 and 2019 two consecutive off-seasons under furrow irrigation systems. The experimental result revealed that there was highly significant difference in days to flowering, 100 seed weight and grain yield among the tested varieties. The variety was significantly interacted with year in days to flowering, grain yield, plant height, numbers of branches, and 100 seed weight.

The grain yield results revealed that the best variety were Awassa-95, Coker-240 and Gozela in 2018 and Coker-240, Gozela and Jallele in 2019 growing season. Two-year combined results of grain yield were ranged from 1147.7 to 2479.8 kg ha^{-1}. The highest grain yield was found by Coker-240 (24.79.8 kg ha^{-1}) followed by Gozela (2293.9 kg ha^{-1}) and Awassa-95 (2286.2 kg ha^{-1}) whereas Nova (1147.7 kg ha^{-1}) and William (1343.3 kg ha^{-1}), were recorded the lowest grain yield, respectively. In this way, soybean varieties Coker-240 basically, and Gozela and Awassa-95 then again are recommended for irrigation environmental conditions in north western and comparable agricultural ecologies of Ethiopia.

REFERENCES

[1] Awulachew, SB.; Yilma, AD.; Loulseged, M.; Loiskandl, W., Ayana, M.; Alamirew, T. 2007. Water Resources and Irrigation Development in Ethiopia. Colombo, Sri Lanka: International Water Management Institute. 78p. (Working Paper 123).

[2] Awulachew, BS., Erkossa, T. and Namara, RE. 2010. Irrigation potential in Ethiopia; Constraints and opportunities for enhancing the system; International water management institute (IWMI).

[3] Basediya, AL., Mishra, S., Gupta, R., Kumar, P., & Basediya, SS., 2018. Performance of Ridge and Furrow System on the Growth and Yield Attribution of Soybean in Barwani District of M.P. International Journal of Current Microbiology and Applied Sciences, 7(08), 499–505.

[4] Bekele, Y., Nata T., Bheemalingswara K., 2012. Preliminary Study on the Impact of Water Quality and Irrigation Practices on Soil Salinity and Crop Production, Gergera Watershed, Atsbi-Wonberta, Tigray, Northern Ethiopia, MEJS. 4(1): 29-46.

[5] Central Statistical Agency (CSA), 2019. Agricultural sample survey report on area and production of major crops (private peasant holdings, meher season). Volume I, statistical bulletin 589, Addis Ababa, Ethiopia.

[6] Food and Agriculture Organization of the United Nations (FAO), 2012a. Towards the future we want end hunger and make the transition to sustainable agricultural and food systems. FAO Viale delle Terme di Caracalla 00153 Rome, Italy.
[7] Food and Agriculture Organization of the United Nations (FAO), 2015. Ethiopia Irrigation market brief. Report No. 25 – September 2015, Viale delle Terme di Caracalla – 00153 Rome, Italy.
[8] Food and Agriculture Organization of the United Nations (FAO Aqua stat), 2016. Area equipped for irrigation and percentage of cultivated land. http://www.fao.org/nr/aquastat Update: November 2016.
[9] Food and agriculture organization of the united nations (FAO), 2018. Guidelines on irrigation investment projects. Rome.122 pp. License: CC BY-NC-SA 3.0 IGO.
[10] Hagos, F., Makombe, G., Namara, RE., Awulachew, SB., 2009. Importance of irrigated agriculture to the Ethiopian economy: Capturing the direct net benefits of irrigation. Colombo, Sri Lanka: International Water Management Institute. 37p. (IWMI Research Report 128).
[11] Ibrahim SE., Han WY. Baek IY. and Cho Gyoung R., 2017. Evaluating Soybean Germplasm for Agronomic Performance under Irrigated Cropping Environment in Sudan. J. Korean Soc. Int. Agric., 29(4): 415~420.
[12] Mulugeta Atnaf, Kassahun Tesfaye and Kifle Dagne, 2015. The Importance of Legumes in the Ethiopian Farming System and Overall Economy: An Overview. American Journal of Experimental Agriculture, 7(6): 347-358.
[13] Perez, Jorge E., High and low yielding soybean lines from an irrigated selection environment: Performance evaluation in irrigated and droughted environments [Dissertations]. (2017). *ETD collection for University of Nebraska – Lincoln*, 2017.
[14] USDA Foreign Agricultural Services, 2019. World agricultural production. United state department of agriculture foreign agricultural service, circular series p7-9.

APPENDIX

Appendix Table 1: - Levene's Test for Homogeneity Variance for yield and yield related traits of early set released soybean varieties

Traits	Sum of Squares		Mean Square		F Value	Pr > F
	Year (1)	Error (46)	Year (1)	Error (46)		
GY	208109	5725679	208109	124471	1.67	0.2
HSW	3.41	140.7	3.41	3.06	1.11	0.3
SdPP	871.7	4002.1	871.7	87	10.02	0.003
SdP	0.3	2.04	0.3	0.04	6.8	0.01
PPP	186.2	1018.9	186.2	22.15	8.41	0.01
DM	7.52	1724.3	7.52	37.49	0.2	0.66
DF	1.02	1512.4	1.02	32.88	0.86	0.39
NB	0.16	40.64	0.16	0.88	0.18	0.67
PH	183.5	2569.7	183.5	55.86	3.28	0.077

Where DF= days to 50% flowering, DM= days to maturity, PH= plant height(cm), PPP= number of pods plant^{-1}, SdPP= number of seeds plant^{-1}, SdP= number of seeds pod^{-1}, NB= number of branch plant^{-1}, HSW= 100 seed weight(gm), and GY = grain yield(kg ha^{-1})