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Research Article

MAIZE YIELD AND YIELD COMPONENTS AFFECTED BY DEFOLIATION RATE AND APPLYING NITROGEN AND VERMICOMPOST

***Fariborz Valikelari[1] and Reza Asghari[2]**
[1]*Department of Agronomy, Neyshabur Branch, Islamic Azad University, Neyshabur, Iran*
[2]*Department of Agronomy, Gorgan Branch, Islamic Azad University, Gorgan, Iran*
**Author for Correspondence*

ABSTRACT
A factorial experiment base on complete randomized block design with 3 replications was taken at experimental field of Azad university of Neyshabur-Iran during 2013. Yield and yield components of NS640 variety of maize was studied. Factor were five defoliation rates, D: (0, 20, 40, 60, 80 %), two nitrogen levels, N: (0 and 150 kg/ha) and two vermicompost levels, V: (0 and 150 ton/ha). Ear length, ear diameter, row/ear, kernel/ear, unfilled kernel number, 100 kernel weight and ear yield measured. Ear length varied between 22.73 to 27.93 cm. Ear lengths enhanced more than 7 percent applying vermicompost. Ear diameter ranged between 38.93 to 49.20 mm. Applying nitrogen enhanced ear diameter about 6 percent. Kernel/ear enhanced about 17% by 40% defoliation compared with 0 and 20% defoliation rates. In all defoliation rates, applying nitrogen and vermicompost resulted in higher kernel/ear amounts. The highest amount of unfilled kernels produced by 0% defoliation rate, 0 kg/ha nitrogen and 0 ton/ha vermicompost. The lowest 100 kernel weight produced by 0% defoliation rate and 0% vermicompost application. The highest ear yield produced by 60% defoliation rate. The highest yield and yield components produced by 40-60% defoliation rate. Late season defoliation resulted in higher kernel number because of reducing competition between leaves and kernels as different sinks thus the final yield increased by defoliation.

Keywords: *Ear Length, Ear Diameter, 100 Kernel Weight, Unfilled Kernel*

INTRODUCTION
Grain yield of maize is product of three yield components i.e. the number of ears per unit of area, the number of grains per ear and the unit grain weight (Gardner *et al*., 1985). Variation in any one of these components, keeping the size of other components constant, contributes to increase or decrease in grain yield, and thus any management factor which increase any of these components, will increase the final grain yield. For example any kind of decrease or inefficacy of corn leaves caused by factors such as pests, diseases, mechanical damages and hail leads to decrease photo-assimilate translocation to the kernels and yield decrease (Echarte *et al.,* 2006). Egharerba *et al.*, (1976) affirmed that maize defoliation 20 day after silking diminish drought material aggregation rate in kernels. Jones *et al.,* (1996) reported that kernel weight and kernel filling duration in maize, significantly affected by defoliation. Prioul and Dugue (1992) stated that grain filling is depended on assimilate remobilization from leaves and defoliation significantly affect it.

Nitrogen is a vital plant nutrient and a major yield determining factor required for maize production (Adediran *et al.,* 1995; Shanti *et al.,* 1997). High grain yield per plant relates to kernel weight and kernel number per cob which both affected by applying nitrogen (Tollenaar, 1977; Uhart and Andrade, 1995). These two yield components show different responses to nitrogen supply. Kernel number is the yield component that is most severely affected by N deficiency (Tollenaar, 1977; Uhart and Andrade, 1995). The response of kernel weight to N shortage is more variable. In some investigations low N supply decreased Kernel weight (Muchow, 1994), whereas in others kernel weight was not affected (Purcino *et al.,* 2000).

Vermicompost is rich in nitrogen, phosphorous, potassium and micronutrients (Ansari and Sukharj, 2010; Palanichamy *et al.,* 2011; Manyuchi *et al.,* 2013; Nath *et al.,* 2009). The bioproduct obtained from the

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vital activity of worms improves soil fertility (Karbauskiene, 2000) and has a very strong stimulating impact on the growth and development of plants (Atiyeh *et al.*, 2000; Makulec, 2002; Arancon *et al.*, 2004). Manyuchi *et al.*, (2013) stated that applying of vermicompost enhance cob weight significantly. They showed that increasing the vermicompost quantity promoted growth of the cob and final yield because of the increase in zinc and phosphorous content.
The aim of this research was to determine the effects of different rate of defoliation and applying nitrogen and vermicompost on yield and yield components of maize.

MATERIALS AND METHODS

A factorial experiment base on complete randomized block design with 3 replications was taken at experimental field of Azad university of Neyshabur-Iran during 2013. The station is at 36° 15´ N latitude and 49° 27´ E longitude and 1354 m altitude with 268 mm of precipitation per year. Yield and yield components of NS640 variety of maize was studied. Factor were five defoliation rates, D: (0, 20, 40, 60, 80 %), two nitrogen levels, N: (0 and 150 kg/ha) and two vermicompost levels, V: (0 and 150 ton/ha). Ordinary field preparation was taken. After soil preparation, fertilizers applied base on soil analysis. Result of soil analysis presents in table 1. Vermicompost added to soil at the same time. Nitrogen spraying applied 4 times during growing season. Defoliation was taken during eighth to eleventh leaf appearance. Yield component traits measured in 10 random plants of each plot too. Ear length and ear diameter measured by ruler and calipers on de-husked ears respectively. Ear yield calculated by harvesting 5 m^2 of maize plants. 100 kernels counted from each 10 ear kernel sample then oven dried at 72 ^oC for 48 hours and weighted by a 0.001 digital scale. All collected data were subjected to analysis of variance using SAS ver 8. LSD tests were done to determine differences between means.

Table 1: Results of field soil analysis

Electrical conductivity (ds m^{-1})	O.C. %	N content %	Elements (mg k g^{-1})							
			Ca	*Mg*	P	K	Cu	Mn	Fe	Zn
1.19	0.65	0.06	40	33	15	196	0.56	8.8	4.25	2.12

RESULTS AND DISCUSSION

Ear Length

Ear-length affected by applying vermicompost.

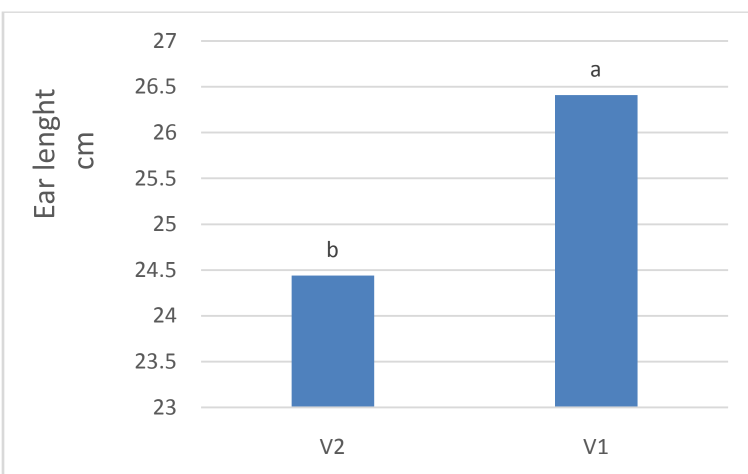

Figure 1: Ear length affected by vermicompost

Effect of defoliation rate and nitrogen fertilizer was not significant on ear length. Interaction between treatment was not significant on ear-length too (table 2). Ear length enhanced more than 7 percent applying vermicompost (figure 1). Ear length varied between 22.73 to 27.93 cm. Vermicompost contains macro and micro elements which contribute in plant and ear growth (Manyuchi *et al.*, 2013). In addition, microbial activities from the vermi-products have been reported to result in production of plant growth regulators such as cytokinins as well as humic acid which promote plant growth (Palanichamy *et al.*, 2011).

Ear Diameter

Ear diameter significantly influenced by nitrogen supplement ($p<0.01$) but not affected by defoliation rate and vermicompost application. Interaction between treatments was not significant on ear diameter too (table 2). Applying nitrogen enhanced ear diameter about 6 percent (figure 2). Ear diameter ranged between 38.93 to 49.20 mm. Higher amount of nitrogen will result in higher assimilate production of top leaves of maize which are the most important sink during sexual phase of maize growth (Tollenaar, 1977).

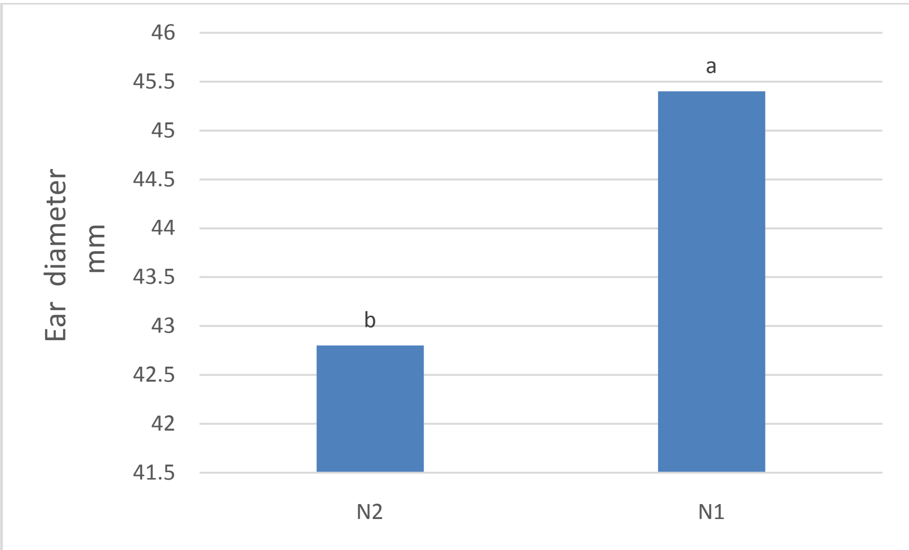

Figure 2: Ear diameter affected by nitrogen (N2:without nitrogen,N1:with nitrogen)

Row/ear

Row/ear did not affect by applied treatments and interaction between them (table 2). Row/ear ranged between 14 and 16.66 rows. Ross *et al.*, (2006) affirmed that row/ear is most controlled by genetic rather than environment.

Kernel/ear

Kernel /ear affected by defoliation rate (table 2). Kernel/ear enhanced about 17% by 40% defoliation compared with 0 and 20% defoliation rates. Kernel number varied between 328 and 742 per ear. The highest kernel /ear produced by 40, 60 and 80% defoliation rates (figure 3). Late season defoliation may results in higher kernel/ ear because of reducing competition between old leaves and ear. Echarte *et al.*, (2006) reported that kernel/ear affect by defoliation rate. Kernel/ear enhanced by applying nitrogen (figure 3). Similar results have been reported by Inamullah *et al.*, (2011). Nitrogen results in higher plant growth and thus enhances grain formation duration which results in higher kernel production (Echarte *et al.*, 2006). Higher kernel/ear produced by vermicompost treatment (figure 3). Vermicompost supply various nutrition elements and growth regulators such as cytokinins which increase plant growth (Palanichamy *et al.*, 2011). Interaction between defoliation, nitrogen and vermicompost was significant of kernel/ear production (table 2). In all defoliation rates, applying nitrogen and vermicompost resulted in higher kernel/ear amounts (figure 3).

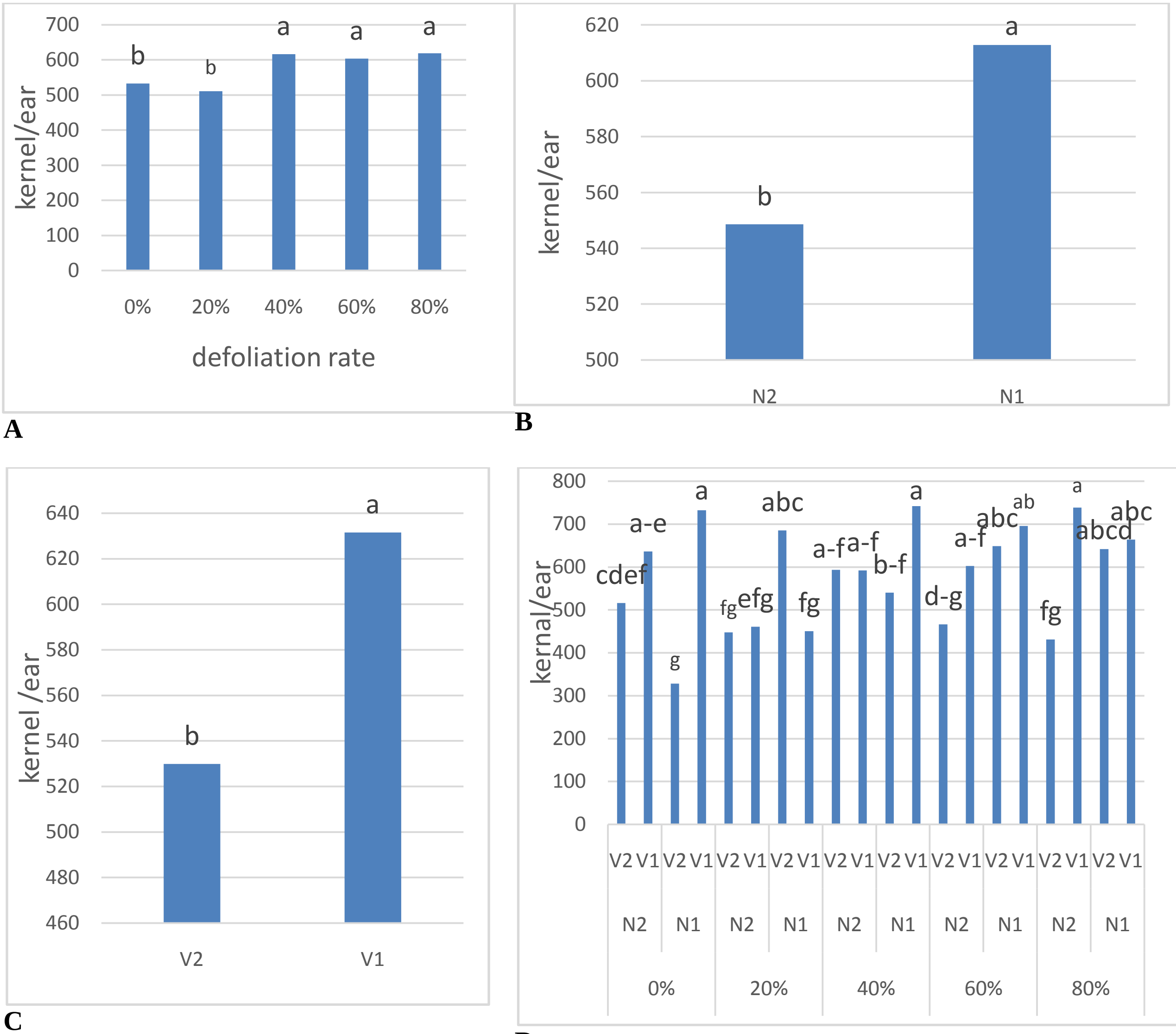

Figure 3: effect of defoliation (A), nitrogen (N2:without nitrogen,N1:with nitrogen) (B), vermicompost (V2:without vermicompost,V1:with vermicompost) (C) and interaction between all treatments (D) on kernel/ear of maize

Unfilled Kernels

An ovule develops into a kernel when its silk receives pollen, is fertilized, and then develops without aborting. Some biotic and abiotic stresses may reduce kernel set due to low pollination or insufficient grain filling. Unfilled kernel number did not affect by defoliation rate, but significantly affect by nitrogen and vermicompost application ($p<0.01$) (table 2). Higher amount of unfilled kernels produced nitrogen and vermicompost did not apply (figure 4). Interaction between treatments was significant on unfilled kernel number (table 2). The highest amount of unfilled kernels produced by 0% defoliation rate, 0 kg/ha nitrogen and 0 ton/ha vermicompost (figure 4).

Nitrogen deficiency may result in unfilled kernels due to lower amount of assimilate availability. Vermicompost is a nutrition source for crops, and could improve maize grain filling by providing essential elements. Adequate defoliation rate decrease competition between old leaves and ear and will result in higher amount of assimilates for grain formation.

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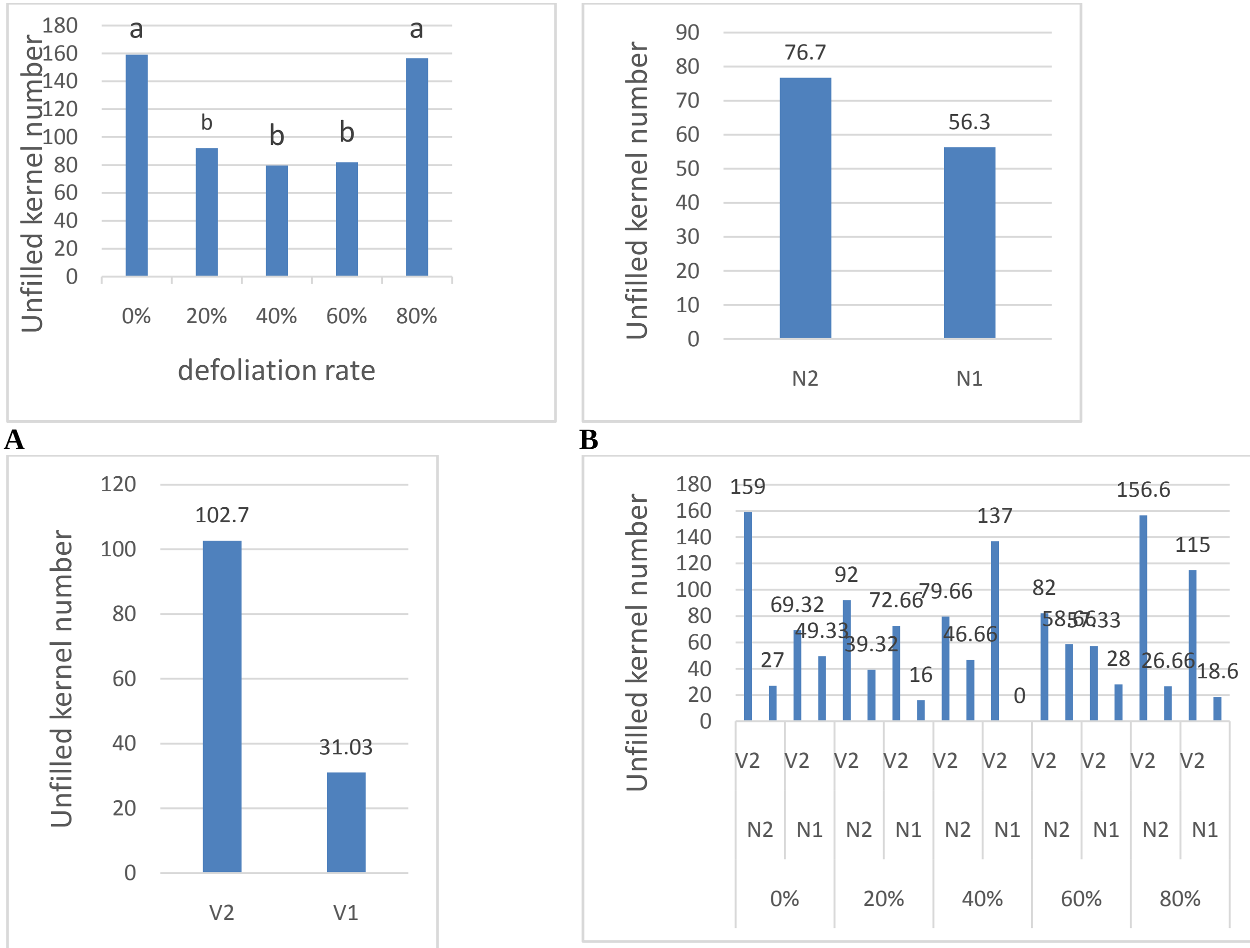


A **B** **C** **D**

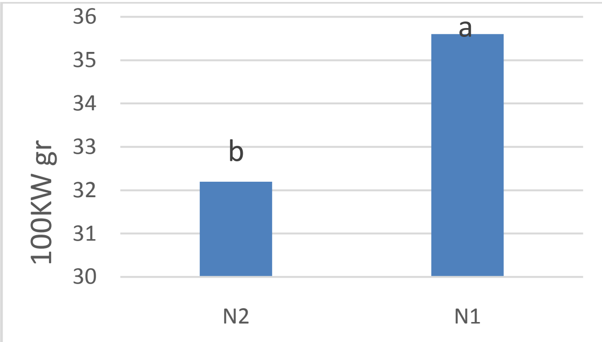
Figure 4: Effect of defoliation (A), nitrogen (B), vermicompost (C) and interaction between all treatments (D) on unfilled kernel number of maize

100 kernels Weight

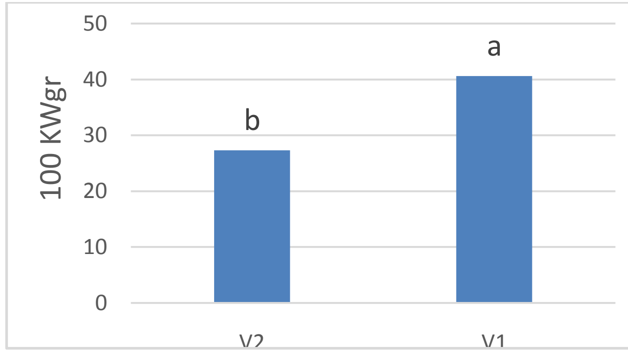
100 kernels weight (100 KW), did not affect by defoliation rate, but interaction between defoliation and vermicompost was significant on it.100 KW also affected by nitrogen and vermicompost application (table 2). 100 KW ranged between 23.66 to 48.33 gr. The higher 100 KW produced in nitrogen supplied treatment (figure 5). The processes involve in kernel weight formation are dependent on the availability of carbon and nitrogen assimilates during formation of the grain sink capacity and during grain filling (Paponov *et al.*, 2001).

Higher amount of stored starch in kernels will results in heavier ones. There is a positive correlation between applying nitrogen and starch content in maize grain (Kmeova *et al.*, 2013). Applying vermicompost enhanced 100 KW of maize (figure 5). Kmeova *et al.*, (2013) find that applying granulated vermicompost has a positive influence on starch content of maize grain. They showed that the lowest content of starch produced in the non-fertilized treatment.

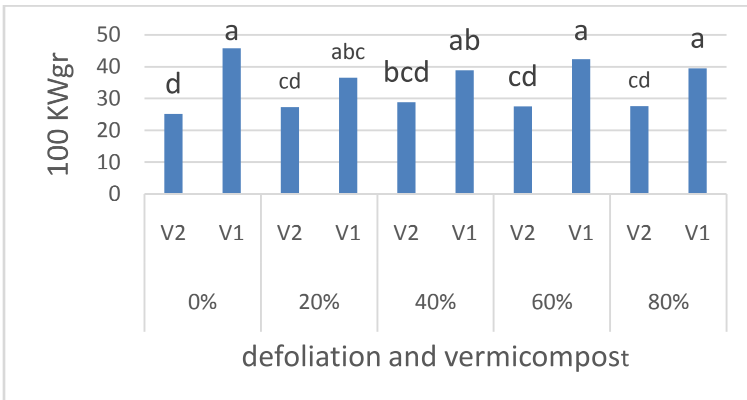
Low kernel weight in N deficient plants at maturity is related to a decreased production of total biomass rather than to low biomass partitioning to the ear (Paponov *et al.*, 2001). The highest 100 kernel weight in all defoliations rates produced applying vermicompost. The lowest 100 KW produced by 0% defoliation rate and 0% vermicompost application (figure 5).



A



B



C

Figure 5: Effect of nitrogen (A), vermicompost (B), and interaction between defoliation and vermicompost (C) on 100 kernel weight of maize

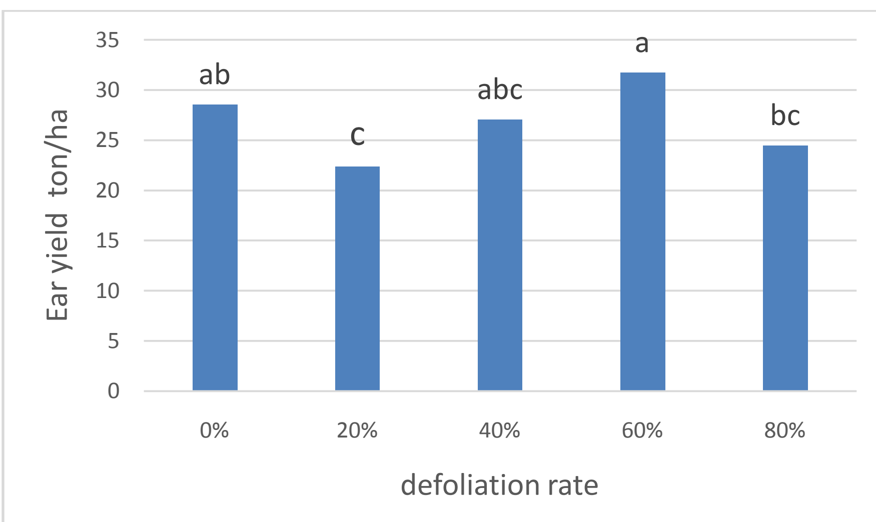


Figure 6: Ear yield affected by defoliation rates

Ear Yield

Ear yield just affected by defoliation rate (table 2). The highest ear yield produced by 60% defoliation rate (figure 6). Leaf elimination results in lower competition for carbohydrates between top ear and other sinks. In this experiment leaves near the ground was eliminated. These leaves aged by late season and could not produce carbohydrates because are shaded by higher leaves. Thus competition between lower part leaves and ear may diminish by defoliation.

Conclusion

Late season defoliation resulted in higher kernel number because of reducing competition between leaves and kernels as different sinks thus the final yield increased by defoliation. The highest yield and yield components produced by 40-60% defoliation rate. Yield enhanced by nitrogen and vermicompost due to higher amount of 100 kernel weight and kernel/ear. Results showed that adequate defoliation may enhance ear yield and nitrogen and vermicompost could compensate lower leaf number in defoliated plants.

Table 2: Analysis of variance of maize measured traits under studied condition

Measured traits	**Source of variation**								**Error**	**CV %**
	Block	Defoliation d	Nitrogen n	Vermicompost v	d*n	d*v	n*v	d*n*v		
Ear length	2.28 n.s	6.27 n.s	6.33 n.s	58.21 **	3.69 n.s	2.42 n.s	0.62 n.s	5.39 n.s	4.66	8.49
Ear diameter	31.91 n.s	19.51 n.s	105 **	49.86 n.s	5.55 n.s	6.47 n.s	0.40 n.s	24.23 n.s	18.64	9.78
Row/ear	1.55 n.s	2.71 n.s	0.60 n.s	0.06 n.s	2.55 n.s	0.69 n.s	9.60 n.s	3.31 n.s	2.93	11.42
Kernel/ear	6359 n.s	26588 **	61888 **	155143 **	15205 **	56336 **	2706 n.s	50367 **	2942	9.34
Unfilled kernel										
100 kernels weight	8.99 n.s	22.55 n.s	177**	2657 **	25.04 n.s	64.7 *	10.6 n.s	41 n.s	23.76	14.31
Ear yield	1006329 n.s	1579281 **	483052 n.s	296947 n.s	362104 n.s	658923 n.s	159918 n.s	757755 n.s	387265	23.18

** and **: significant at 5 and 1 % probability levels and ns: not significant*

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