Indian Journal of Ecology (2025) 52(2): 350-353
DOI: https://doi.org/10.55362/IJE/2025/4500

Manuscript Number: 4500
NAAS Rating: 5.38

Effect of Ascorbic Acid and Harvest Date on Various Traits and Yield Loss of Corn

Ather Saber Mustafa, Kotada Ibrahim Abdulla, Labed Shareef Mohammed

Department of Field Crops, College of Agriculture, Tikrit University, Salah Addin, Iraq
E-mail: atheragriculture@tu.edu.iq

Abstract: Experiment was conducted to study the effect of ascorbic acid and harvest date on various traits and yield of corn, an at the College of Agriculture Research Station, Tikrit University. The experiment consisted of three local varieties of corn (Baghdad, Sara, and Fajir), three concentrations of ascorbic acid (0, 100, and 200 mg L^{-1}), and three harvesting date (30, 40, and 50 days) after pollination. There were no significant differences among varieties for studied traits. The ascorbic acid 200 mg L^{-1} resulted in significantly higher broken grains percentage and broken grain (2.587% and 180.09 kg h^{-1}, respectively). Furthermore, this treatment produced higher net grain yield of 6790 kg h^{-1}. Harvest date had significant effect on all studied traits and moisture percentage was decreased significantly by 15% between the first and third dates of harvest and remaining grains percentage in cob after shelled and its weight were increased. Percentage of broken grains was increased from 0.771 to 3.563%, weight increased from 54.23 to 232.94 kg h^{-1} and total grain loss increased from 1.301 to 6.972% as harvesting early from 50 to 30 days after pollination, while the net grain yield was decreased from 7203 to 6080 kg $h^{-1}$for the same two dates, respectively.

Keywords: Corn, *Zea mays,* Ascorbic acid, Percentage loss

Corn (*Zea mays* L.) is an important crop in Iraq and is cultivated during spring and fall seasons. In Iraq, the importance of this crop is the direct use as human nutrition and corn grain is used to feed animals, poultry and livestock, due to its high nutritional value. Although the importance of this crop, the cultivated areas were decreased to 76 thousand hectares in 2016 with a productivity rate of 3.4 tons h^{-1} (FAO 2018). The most important reasons for the decline in the cultivation and low productivity/unit area of this crop is the presence of gypsum soils in Iraq in more than 8 million hectares. Gypsum soils are characterized by their weakness in terms of fertility, chemical and physical characteristics, in addition to the problems of planting and harvesting dates during spring and fall seasons, and irrigation and water provision problems (Khairo 2016). The important problem facing this crop is the date of harvest and high moisture content in the grain and yield loss, whether by mechanical or manual harvesting, cleaning and shelling of grains. In addition, locally developed genotypes suitable for cultivation in gypsum soil and harvest dates without affecting the yield are important matters for improving the growth and yield of this crop and reducing the loss of the yield.

In order to overcome these problems, it is useful to use some growth stimulants such as plant growth regulators and vitamins to improve the yield, including ascorbic acid, which play an important role in increasing cell division and elongation, improving shoot and root growth, and activating carbon representation as an electron donor (Abrahamian and Kantharajan 2011). Furthermore, in order to reduce the damage of gypsum soil, the identification of the appropriate harvest date is a great importance to minimize damage of the yield and reduce its loss rates. Timely harvest of crop is important when moisture in the grain drops below 20%. Early harvest leads to high moisture content in the grain, but reduces the time the crop stays in the field to exploit the land for the subsequent crop. On the other hand, it causes yield loss during harvest, shelling, and cleaning when the harvest is delayed for a long period (Metz 2006), and high moisture content in grain at harvest increases the loss to 11.73% when mechanically harvested. Therefore, the research aims to test the effect of three concentrates of ascorbic acid on losses in the grain yield at three harvest date.

MATERIAL AND METHODS

Experiment was conducted at College of Agriculture, Tikrit University in gypsum soil (17% gypsum) during 2017 fall season. The experiment was carried out with a randomized complete block design with a split-split plot arrangement of treatments in three replications. The treatments were three local varieties of corn (Baghdad, Sara, and Fajir), three concentrations of ascorbic acid (0, 100, and 200 mg L^{-1}), and three harvest date (30, 40, and 50 days) after pollination. Varieties were allocated to the main plots; ascorbic acid concentrations were allocated to sub plots, harvest date to sub-sub plots. Planting date was on July 15, 2017 with six rows for each treatment with distance of 75 cm and 25 cm in rows and among plants. Phosphate fertilizer (super calcium phosphate), 200 $kg.h^{-1}$, was added with the first batch of

nitrogen fertilizer (Urea 46% N) at the planting date. The second and third batches were added at six leaves stage and inflorescences stage, respectively at 400 kg h^{-1}. Plants were sprayed with ascorbic acid at four leaves stage with a diffuser material to reduce the surface tension and to facilitate the penetration and spread of the solution into the leave tissues. When the plants reached the stage of emergence male and female inflorescences, paper bags were placed on them, then plants were manually pollinated and the pollination dates were recorded. After that, bags were re-placed on the ears for two weeks, then they were removed and the harvested at deferent days (20, 30, 40, and 50 days after the recorded pollination dates). Ears were harvested according to the type of treatment of the harvest date with 10 plants for each treatment taken randomly at the same day.

Sample of seeds was taken from each harvested ear representing one row and weighed immediately after harvesting, and was dried in an electric oven at 70° C until constant Moisture content of the grains was calculated by using the following equation:

$$\% \text{ remaining grains in cob} = \frac{\text{Number of remaining grain in cob}}{\text{Total number of grain}} \times 100$$

Ears were naturally dried to a moisture of 14%, and then were shelled by shelling machine, and the following studies were taken:

Percent remaining grains in the cob after shelling:

$$\% \text{ broken grain} = \frac{\text{Number of broken grain}}{\text{Total number of grain}} \times 100$$

The weight of remaining grains in the cob after the shelling was calculated and then converted to kg h^{-1} by plant density.

Percent broken grains:

$$\% \text{ moisture} = \frac{\text{Grain weight before drying} - \text{grain weight after drying}}{\text{Grain weight before drying}} \times 100$$

Weight of broken grains: This was calculated by weighing the broken and incomplete grains and then converted to kg h^{-1}

Percent total loss: It rpresents the percentage of the remaining grains in the cob plus the broken grains.

Weight of total loss (kg h^{-1}): It represents the weight of the remaining grains in the cob and the broken grains.

Net grain yield (kg h^{-1}): It represents the total grain yield of clean and undamaged grains and then converted to kg h^{-1}

RESULTS AND DISCUSSION

Effect of varieties: There were no significant differences among the varieties and behaved similarly in terms of being affected by the other studied factors (ascorbic acid and harvest date) (Table 1). The average of moisture content in the grains was 23.63, 23.31 and 22.82% in Baghdad, Fajir, and Sara varieties, respectively. These varieties did not differ in the percentage of total grain loss and gave net grain yield of 6738, 6646 and 6695 kg h^{-1}, respectively. This may be due to the fact that the three varieties (Baghdad, Sara, and Fajir) were derived from the same origins and under the conditions of Iraq through selection.

Effect of ascorbic acid: The ascorbic acid had a significant effect on the broken grain percentage, broken grain weight, and net grain yield (Table 2). The spraying with ascorbic acid at 200 mg L^{-1} resulted in the highest broken grain percentage and broken grain weight (2.587% and 180.09 kg h^{-1}, respectively) while this treatment produced the highest net grain yield 6790 kg h^{-1}. This may be due to the role of ascorbic acid in the stimulating of biological processes, especially the processes of absorption by the plant (Hussein et al. 2011), building the shoot and root systems and dry weight (Atta Ullah et al 2016), stimulating many enzymes (Tedone 2004), conservation of chlorophyll, increase the rates of photosynthesis, and transfer dry matter to the grain (Shahnawas et al 2017). Darvishan et al (2013) indicated that spraying with ascorbic acid caused a significant increase in the yield. The increase of grain yield due to the ascorbic acid spraying may be attributed to the high the broken grain percentage and broken grain weight compared to control treatment. The percentage of moisture in the grain, the loss due to the weight of the remaining grains in the cobs after shelling and its percentage, the percentage of total loss, and the weight of the total lost grains were not significantly affected by the concentration of ascorbic acid.

Effect of harvest date: The early and late date of the harvest caused significant differences in the studied (Table 3). Moisture content was decreased from 31.40 to 16.27% when the harvest date was delayed from 30 days to 50 days with a decrease of more than 15%. The delay of harvesting led to increase grain loss by shelling, so percentage of the remaining grains in cob and weight was increased by harvesting early with 0.5248, 2.0922, and 3.4085%; and 39.98, 149.33, and 222.27 kg h^{-1} when harvested at date of 50, 40 and 30 days after pollination, respectively. The percentage of the broken grains weight, the percentage of total loss, and the total grain weight loss during shelling increased when the harvest date was delayed. But there was increase in the percentage of broken grain loss from 0.7719 to 3.563%, weight from 54.23 to 232.94 kg h^{-1}, the percentage of the total grain loss and its weight from 1.301 to 6.972% and from 94.21 to 457.02 kg h^{-1}, respectively when the harvest date was delayed from 30 to 50 days after pollination. The net grain yield decreased from 7203 to 6080 kg h^{-1} when

harvesting early from 50 to 30 days after pollination, respectively. Patel and Varshney (2014) also showed that an increase in moisture content leads to increase the yield loss to a percentage that may reach more than 11%, and the appropriate time to harvest corn is at moisture content 20% or less (Mets 2006). Siddique and Wright (2003) and Samara et al. (2005) indicated that early harvest time caused higher moisture content, lower grain weight, lower grain yield, and higher broken grains during harvest and shelling. Vera et al. (2006) also observed that early harvest resulted in lower yields due to incomplete accumulation dry matter in grains.

Interaction between varieties × concentrations: There were significant interaction between varieties and ascorbic acid concentration in percentages of the broken grains, their weight, and the net grain yield (Table 4). In Baghdad × 200 mg L^{-1} broken grains percentage and weight was significantly higher (2.854% and 200.92 kg h^{-1}, respectively) and lowest was in Sara × 100 mg L^{-1} with (2.044%, 139.63 kg h^{-1}, respectively). This t indicates that interaction between the varieties and acid concentration in broken grains percentage, their weight, and net grain yield, had a different behavior. The difference of the varieties' response to the acid concentrations showed significant effect. There was no significant difference in the response of the varieties to ascorbic acid concentration in these traits.

Interaction between varieties × harvest date: The interaction between varieties and harvest date had a significant effect on the percent of total grain loss, and

Table 1. Effect of varieties Baghdad, Fajir and Sara on various traits

Varieties	% moisture	% remaining grain.ear^{-1}	Grain weight. ear^{-1} (gm)	% broken grain	Broken grain weight (kg h^{-1})	%total loss	Total weight loss kg h^{-1}	Net grain yield kg h^{-1}
Baghdad	23.63a	1.9467a	136.05a	2.477a	170.12a	4.4056a	308.041a	6738.55a
Sara	23.31a	1.9959a	134.70a	2.352a	159.33a	4.3533a	294.033	6646.06a
Fajir	22.82a	2.0830a	140.84a	2.351a	161.51a	4.4341a	302.352a	6695.28a

Table 2. Effect of ascorbic acid concentrations on various traits

Con. mg l^{-1}	% moisture	% remaining grain ear^{-1}	Grain weight. (gm)	% broken grain	Broken grain weight (kg h^{-1})	% total loss	Total weight loss kg h^{-1}	Net grain yield kg h^{-1}
0	23.33a	2.200a	149.66a	2.377ab	157.70b	4.564a	309.17a	6557.17a
100	23.05a	2.064a	140.36a	2.217b	153.18b	4.280a	293.17a	6731.75a
200	22.39a	1.761a	121.56a	2.587a	180.00a	4.348a	293.54a	6790.96a

Table 3. Effect of harvest date on various traits

Days after pollination	% moisture	% remaining grain ear^{-1}	Grain weight. (gm)	% broken grain	Broken grain weight (kg h^{-1})	% total loss	Total weight loss kg h^{-1}	Net grain yield kg h^{-1}
30	31.40a	3.4085a	222.27a	3.563a	222.27a	6.972a	457.02a	6080.55c
40	22.10b	2.0922b	149.33b	2.846b	149.33b	4.920b	353.19b	6795.40b
50	16.27c	0.5248c	39.98a	0.7719c	54.23c	1.301c	94.21c	7203.93a

Table 4. Effect of interaction between varieties × ascorbic acid concentration on various traits

Varieties	Concentration (mg l^{-1})	% moisture	% remaining grain.ear^{-1}	Grain weight. ear^{-1} (gm)	% broken grain	Broken grain weight (kg.h^{-1})	%total loss	Total weight loss kg.h^{-1}	Net grain yield kg.h^{-1}
Baghdad	0	24.58a	2.0222a	146.62a	2.252ab	147.81b	4.219a	299.88a	6683.5abc
	100	23.14a	2.3079a	157.79a	2.326ab	161.64ab	4.633a	319.43a	6738.0abc
	200	23.17a	1.5100a	103.73a	2.854a	200.92a	4.364a	304.81a	6794.2ab
Sarah	0	23.19a	2.2567a	151.01a	2.480ab	164.62ab	4.751a	315.63a	6472.2c
	100	23.91a	1.8411a	123.01a	2.044b	139.63b	4.885a	262.64a	6708.9abc
	200	22.83a	1.8900a	130.07a	2.533ab	173.75ab	4.432a	303.82a	6757.1abc
Fajir	0	22.21a	2.3220a	151.34a	2.400ab	160.67b	4.722a	312.01a	6515.0abc
	100	22.10a	2.0422a	140.28a	2.280ab	158.27ab	4.322a	298.56a	6748.3abc
	200	24.15a	1.8844a	130.89a	2.373ab	165.60ab	4.258a	296.49a	6821.6a

Table 6. Effect of interaction between ascorbic acid concentration × harvest date on various traits

Concentration (mg l^{-1})	Harvest date (days after pollination)	% moisture	% remaining grain.ear^{-1}	Grain weight. ear^{-1} (gm)	% broken grain	Broken grain weight (kg.h^{-1})	%total loss	Total weight loss kg.h^{-1}	Net grain yield kg.h^{-1}
0	30	31.56a	3.541a	2258a	3.777a	243.2a	7.318a	474.5a	5439.3d
	40	22.06b	2.411b	168.7bc	2.650b	186.1b	5.007b	354.8b	6650.9c
	50	16.35c	0.649c	54.4d	0.705c	43.7c	1.368c	98.17c	7081.3ab
100	30	31.57a	3.609a	235.5a	3.347a	221.0ab	6.956a	458.5a	6132.4d
	40	21.45b	2.042b	146.6c	2.622b	188.8b	4.664b	335.4b	6851.9bc
	50	16.12c	0.540c	36.9d	0.631c	49.7c	1.220c	86.61c	7210.9a
200	30	31.05a	3.075b	203.4ab	3.566a	234.5ab	6.642a	437.9a	6169.9d
	40	22.78b	1.823b	132.6c	3.265ab	236.5ab	5.089b	369.28b	6883.4bc
	50	16.33c	0.385c	28.6d	0.929c	69.2c	1.314c	97.86c	7319.6a

highest was 7.215% in Fajir × 30 days after the pollination There was with no significant difference interaction between two varieties (Baghdad and Sara) with the same harvest date (30 days after pollination).

Interaction between ascorbic acid concentration × harvest date: Interaction between the acid concentration and harvest date showed a significant difference (Table 6). The interaction 100 mg L^{-1} × 30 days after pollination was superior in of moisture percentage, the percentage of grains in ear and weight (31.57%, 3.609%, and 235.5 kg $^{-1}$, respectively). The interaction non-additive (0) × 30 days after pollination gave the higher percentage of broken grains, its weight, total loss percentage, and its weight, (3777%, 243.2 kg h^{-1}, 7188%, and 474.5 kg h^{-1}respectively) . There was significant effect of the harvest date on all traits and non-significant effect of the ascorbic acid concentration on moisture percentage, percentage of the remaining grains in the cobs and their weight, and the percentage of total loss and its weight. These traits were more affected by the harvest date. The significant effect of the ascorbic acid concentration on the traits of broken grain percentage, its weight, and net grain yield indicated that the factors of concentration and harvest date behaved differently.

CONCLUSION

The Baghdad variety was superior with under the effect of ascorbic concentration and different harvest date, and the opposite effect of the ascorbic acid on yield and on the reduction of yield loss on the early harvest date. The harvesting of corn plants cause increasing grain moisture, broken grain and yield loss.

REFERENCES

Abrahamian P and Kantharajan A 2011. Effect of vitamins on in vitro organogenesis of plant. *American Journal of Plant Sciences* **2**: 669-674.

Alta- Ullah HF, Wahid JA and Sadia B 2016. Alleviating effect of exogenous application of ascorbic acid on growth and mineral nutrients in cadmium stressed barley (*Hordeum vulgare* L.) seedling. *International Journal Agriculture Biology* **18**(1): 73-79.

Darvishan MHR, Moghadam T and Zahedi H 2013. The effect of foliar application of ascorbic acid (vit C) on physiological and biochemical changes of corn (*Zea mays* L.) under irrigation with ding in different growth stages Dept. of Agron and plant Breeding. *Eslamshahr Branch Azad University Tehran*, Iran **58**: 195-200.

Hussein MM, El-Rheem KM, Khaled SM and Youssef RA 2011. Growth and nutrients status of wheat as affected by ascorbic acid and water salinity. *Natural Sciences* **9**: 64-69.

Khairo AM 2016. Water consumption use of autumn corn (*Zea maya* L.) under deficit irrigation condition in a gypsiferous soil / Salahaddin province

Metz N 2006. The WA Guide to high moisture harvest management, grain storage and handling CBH Group PP-2-5.

Patel SK and Varshney BP 2014. Modeling of what crop harvest losses. *Agricultural Engineering International* **16**(2): 97-102.

Samara N 2005. Seed maturity and drying methods harvest are critical seed desiccation tolerance and quality: Impact of food security. *Agronomy for Sustainable Development* **25**: 145-149.

Shahnawz MD, Chauhan R and Sanadhya D 2017. Import of aluminum toxicity on physiological aspects of barley (*Hordeum Vulgare* L.) varieties and its alleviation through ascorbic acid and salicylic acid seed priming. *International Journal of Current Microbiology and Applied Sciences* **6**(5): 875-891.

Siddique AB and Wright D 2003. Effect of time of harvest at different moisture contents on seed fresh weight, dry weight, quality (Viability and Vigor) and food reserves of peas (*Pisum sativum* L.). *Asian Journal of Plant Sciences* **2**(13): 983- 992.

Tedone L 2004. Long distance transport of L- ascorbic acid in potato. BMC *Plant Biology*, Dundee **4**(16): 1-8.

Shahnawz MD, Chauhan R and Sanadhya D 2017. Import of aluminum toxicity on physiological aspects of barley (*Hordeum Vulgare* L.) varieties and its alleviation through ascorbic acid and salicylic acid seed priming. *International Journal of Current Microbiology and Applied Sciences* **6**(5): 875-891.

Vera CL, Downey RK, Woods SM, Raney JP, Grego DIM Elliett RH and Johnson EN 2007. Yield and quality of canola seed as affected by stage of maturity at swathing. *Canadian Journal of Plant Science* **78**: 13-26.

FAO 2018. Crop and livestock products. www.fao.org/faostat/en/#data/tp.

Received 12 November, 2024; Accepted 18 February, 2025