Effect of sowing date, density and seed priming on silage yield dependents parameters of corn in summer delay cropping after rice harvesting in the north of Iran

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Abstract: To evaluate the effectiveness of pretreatment of seed priming on the plant and determine the optimum planting date and plant density of silage corn cv. 704 in late summer after rice harvesting, an experiment design was carried out in randomized complete block design in split-split plot with four replications in the Agricultural Research Center of Gharakheil, Mazandaran, Iran in 2010 and 2011. Planting dates in two levels (July 28 and August 12) as main factors, two planting densities (7 and 9 plants per square meter) as sub plots and subplots - including four levels of seed priming (pure water, PEG (8000), KNO_3 and control) respectively. The results showed that the number of days to leave the coleoptiles in 1389 than in 1390 which led to the increase in hay yield and total dry weight ratio in 1389 was to the ear. Hay yield with delayed planting 7.31 percent decrease. Compared to the total dry ear and all morphological traits with delayed planting decreased. Days from planting to emergence of coleoptiles were less delay in planting. Hay yield increased with density 4.21 percent increase was less but the number of days from planting to emergence of coleoptiles. Ear length and ear height from ground level, with increasing density decreased and increased respectively. Before seed priming with water and PEG (8000), respectively, decreased the number of days to different stages of plant growth by increasing the ratio to the total dry weight per ear was forage.

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1. Introduction

Corn production based on FAO documents (2005) accounts for 2.8% of total cereals production in Iran, with 1.6 million tones grain production from 0.25 million hectares cultivated land, in spite of the fact that the production of hybrid seed is too low. Average annual rainfall in Iran is about 251mm. In dry years, when seed zone water is inadequate, farmers have to delay planting which will reduce grain yield potential compared with early planting (Donaldson *et al*., 2001). Osmo-priming and hydro-priming of seeds may improve germination and emergence (Ashraf and Abu-Shakra, 1978) and may promote vigorous root growth (Carceller and Soriano, 1972). Corn requires a minimum temperature of 50°F to germinate, and even at 55°F germination and growth are slow. Soil temperatures under conventional tillage can be higher than air temperatures if several days of bright sunshine have provided energy for soil warming. A range of planting dates results in crop exposure to different stress factors with later plantings generally being subjected to more diseases and insects. In addition, cold soils at early plantings and cooler late-season growing conditions at later plantings broaden a-biotic stresses to the crop. Several authors have demonstrated that negative impacts of adverse environmental conditions can be dampened by transplanting (Welbaum et al., 2001), adjusting plant population density (Rangarajan et al., 2002), or seeding depth (Barr et al., 2000). Management of pests is affected by the environmental conditions associated with different planting dates (Malvar et al., 2002; Williams, 2006). In comparison of dent corn hybrids differing in relative maturity, phonological development of late-maturing hybrids was affected most by delayed planting (Nielsen et al., 2002) and photoperiod (Hunter et al., 1974). Maximum yield was achieved by planting dent corn May 10, whereas planting earlier or later reduced leaf area index, leaf area duration, total biomass, and grain yield (Swanson and Willhelm, 1996). From research in Newfoundland, where conditions permit only short-season (62- to 67-d) hybrids to be grown, days from planting to emergence decreased some 50% through May because of cold soils early in the month (Kwabiah, 2004). In addition, corn yield increased as planting was delayed through May, presumably as stand establishment improved. An 82-d hybrid in Illinois grew on average 22 cm taller with 18% more total shoot biomass and 43% less leaf area index

(LAI) when planted in late June compared with early May (Williams and Lindquist, 2007).

Seed row spacing is an agronomic management strategy used by producers to optimize the husbandry of the soil and plant ecosystem from sowing to harvest with the goal of bolstering the production of crops (Sharratt and McWilliams, 2005). Crop row spacing influences canopy architecture, which is a distinguishing characteristic that affects the utilization of light, water, and nutrients (Sharratt and McWilliams, 2005). Widdicombe and Thelen, (2002), however, found that higher yields were attained for corn grown in narrow rows versus wide conventional rows irrespective of hybrids and plant populations tested in Indiana and Michigan. Although the optimum row spacing varies among plant genus, yields will generally be maximized by sowing in rows that result in an equidistant spacing among plants (Sharratt and McWilliams, 2005). Pedersen and Lauer (2003) found an 11% lower yield for corn grown in 0.19-m rows. Wisconsin while Farnham (2001) found a 2% lower yield for corn grown in 0.38-m rows versus 0.76-m rows in Iowa. Crop row spacing can also influence soil water utilization (Sharratt and McWilliams, 2005).

The general purpose of seed priming is to hydrate partially the seed to a point where germination processes are initiated but not completed. Most priming treatments involve imbibing seed with restricted amounts of water to allow sufficient hydration and advance of metabolic processes but preventing the protrusion of the radicle. Treated seeds usually would exhibit rapid germination when absorb water under field conditions (Ashraf and Foolad, 2005). Maize seed soaked by 2.5% KCl for 16h reduced coleoptile and radicle length, while seed soaked in 20 ppm GA_3 for 30 min improved some germination traits, but could not affect grain yield (Subedi and Ma, 2005). Significant improvement in field emergency, seedling character also high synchronization of silking and anthesis for maize genotype was achieved through the hyropriming for 24 h (Nagar *et al.*, 1998). Seed priming has been found a double technology to enhance rapid and uniform emergence, and to achieve high vigor and better yields in some field crops (Chiu *et al*., 2002; Giri and Schillinger 2003; Murungu *et al*., 2004; Basra *et al*., 2006; Kaur *et al*., 2005; Farooq *et al*., 2006; 2007). Priming allows some of the metabolic processes necessary for germination to occur without germination take place. In priming, seeds are soaked in different solutions with high osmotic potential. In addition to better establishment, farmers reported that primed crops grew more vigorously, flowered earlier and yielded higher (Farooq et al., 2008). Water has also been used successfully as a seed priming medium for wheat (Harris et al., 2001). In maize (*Zea mays* L.) inbred lines, maximum invigoration was observed in seeds hydro- primed for 36 h as indicated by higher germination rate and longer radical length (Moradi Dezfuli et al., 2008).

Objectives of this study was effectiveness of pretreatment of seed priming on the plant and determine the optimum planting date and plant density of corn silage were 704 in late summer in north of Iran.

2. Material and Methods

In order to evaluate the effectiveness of pretreatment of seed priming on the plant and determine the optimum planting date and plant density of silage corn cv. 704 in late summer after rice harvesting, an experiment was carried out at the of Agricultural Research Center of Gharakheil, Qaemshahr, Mazandaran, Iran in 2010 and 2011. The experimental farm is geographically situated at 28°, 36' N latitude and 28°, 56' E longitude at an altitude of 14.73 m above mean sea level. Before seeding, soil available N, P, and K were determined for depth 0 -30 cm. The soil type was classified as clay loam. Some of its properties are as follows: 43, 32 and 25 g kg^{-1} clay, silt and sand, respectively; organic matter, 3.5-4.2 g kg^{-1}; pH, 7.5-7.8; 0.22, 12 and 180 available N, P and K, respectively. Weather conditions were also measured in vegetation period (Figure 1 and 2).

This experiment was conducted as split-split plot in randomized complete blocks design based four replications. Planting dates in two levels (July 28 and August 12) as main factors, two planting densities (7 and 9 plants per square meter) as sub plots and subplots - including four levels of seed priming (pure water, PEG (8000), KNO3 and control) respectively.

Individual plots were 7 rows (75 cm by 6 m long. The plot size (experimental unit) was 6 by 7 m. Cultivar corn was a single cross hybrid (*Zea mays* L. cv. single cross 704) that was popular among growers in the north Mazandaran during the period of this study. Plots were over planted and hand-thinned to achieve the desired target plant densities. In site, seeding rates were adjusted for based on germination of the cultivar. The land was prepared for planting by disk followed by cultivator tillage. Immediately after tillage, plots were seeded 15 to 20 mm deep using a hand with row spacing. The site was irrigated with 25 mm of water using a sprinkler irrigation system when soil water was, 60% of field capacity. With attention to seed priming treatment, first seeds was used in solution within 24 hours, then seeds out of solution and dried. Then Planting operations were performed. Nitrogen, P, and K fertilizers were applied according to yield potentials and soil test levels for site. Fertilizer use as N, P and K (400–300–50, N–P–K) from urea, ammonium phosphate and potassium sulfate. Fertilization was incorporated mid-row banded into soil 38 to 40 mm deep using a shallow rotary tillage before seeding. The tillage operation was oriented the length of the plots to minimize possible inter plot movement of fertilizer. The experimental site received 92 kg N ha^{-1} broadcast after plowing, before planting, and a further 46 kg N ha^{-1} split in half and side-dressed 30 and 40 d after planting (at the fifth leaf stage). Weeds were controlled using pre-plant herbicides and hand weeding was done where necessary. The previous crop at site was wheat as second crop. Plants were cut at the surface from the central of the three middle rows in the plots. All plots were harvested using hand in growth stage soft dough. Ears were separated, weighed and the moisture content was measured. Silage yield was determined by harvesting one 4 m^2 area of each plot at harvest. Dry forage yield was calculated from stover and ear weights, which were adjusted to oven-dry weights after subsamples of ear and stover were dried at 70^{-C} for 72 h, and weighed. The plant samples were oven dried. Fresh weight of ear and stover were measured in the field. All ears were then dried in a forced-air oven at 70°C for 1 wk. Five plants were randomly selected at harvest from each plot to estimate leaf, stem and ear fresh weight. Data were analyzed using the SAS procedure to develop the ANOVA for a factorial design (SAS 2001). The DMRT procedure was used to make tests of simple and interaction effects by MSTAT-C, all differences reported are significant at $P \leq 0.05$ unless otherwise stated.

3. Results and Discussion

Phonological traits:

With attention to Table 1, phonological traits had significant effect under year and sowing date in 1% probability level and significant effect on seed priming in 5% level, as number of days to coleoptiles emergence had significant effect on density and interaction of year sowing date in 1 probability level (Table 1). In first year corn during this process would take less time to reach, as the most number of days to coleoptiles emergence and tassel emergence had obtained in July 28 (8.39 days) and August 12 equivalent to 63.8 days (Table 2). Growth rate in different growth stages on seed priming were similar conditions. So that, crop growth had increased when seed was pre-treated with pure water, as with increase plant density coleoptiles to spend less time for out of soil. In second year with delay in planting, coleoptiles emergence rate (5.97 days) was increased. However, in second year with sowing 28 July coleoptiles to spend longest time for out of soil (Table 3). Khan et al., (2002) reported that with delay in cropping number of days to tassel emergence and maturity was decreased. Khan et al., (2009) reported that seed priming cause of necessary period for 50% germination. Days from crop emergence to silking varied with planting date. As planting was delayed from mid-April to early July, 23% to 35% fewer days until silking were observed (Martin and Williams, 2008). Nielsen et al., (2002) showed that thermal time to silking changed little for three commonly grown dent corn hybrids of the north central United States as planting was delayed from early May to mid-June.

Ear length and ear diameter:

Combined analysis of the data showed that ear length and ear diameter was affected by year and sowing date ($P \leq 0.01$), but only ear length has significant effect under plant density in 1% probability level. Ear length and diameter had significant effect under double interaction of year and sowing date and quadratic interaction in 5 % probability level sequentially (Table 1). Maximum ear length and ear diameter was observed in first year equivalent to 3.82 and 28.17 cm, respectively, and in sowing date of 28 July these traits ratio to delay sowing date was the best. As between density and ear length was negative correlation that with increase density ear length was decreased (Table 2). In second year with delay in cropping ear diameter (2.91 cm) had significantly decreased, as the least ear length (24.93 cm) was observed with increased density, delay in cropping and non seed pre-treatment (Table 5). There are some studies on the effect of seed priming on germination and growth rate of maize. Basra *et al.* (1989) found that priming of corn seed using polyethylene glycol or potassium salts (K_2HPO_4 or KNO_3) resulted in accelerated germination at a chilling germinator (10°C). Maize seed soaked by 2.5% KCl for 16h reduced coleoptiles and radicle length, while seed soaked in 20 ppm GA_3 for 30 min improved some germination traits, but could not affect grain yield (Subedi and Ma, 2005). Significant improvement in field emergency, seedling character also high synchronization of silking and anthesis for maize genotype was achieved through the hydro-priming for 24 h (Nagar *et al.*, 1998).

Stem diameter and ear height from ground surface:

Results showed ear height from ground surface had significant effect under planting date and density in 1% probability level, as stem diameter was effect by sowing date and triple interaction of year × sowing date × plant density in 1% and 5% probability level, respectively (Table 1). The most ear height from ground surface was obtained for 28 July (124.13 cm) and 9 plant per square meter (120.43 cm). As stem diameter was decreased with delay in cropping (Table 2). In both years and plant densities with delay in cropping stem diameter was decreased (Table 6). In addition, thermal time to maximum absolute height growth rate (i) increased through the growing season with the exception of the last two planting dates of 2007 (Martin and Williams, 2008).

Dry forage yield and its components:

As we see in Table 1, dry weight per plant and dry forage yield had significant effect under year in 5% probability level, and dry weight of leaf, stem and ear to total forage yield was effect by year in 1%. All of mention traits had significant under sowing date in 1% probability level, as dry forage yield and dry weight of leaf to total forage yield was effect by plant density in 5% probability level. Dry weight of stem and ear to total forage yield had significant effect under seed pre-treatment in 1% level. Dry weight per plant and dry weight of stem to total forage yield was significant an double interaction of sowing date × seed priming and plant density × seed priming in 5 probability level. Dry forage yield and dry weight of ear to total forage yield was effect by double interaction of plant density × seed pre-treatment and sowing date × seed pre-treatment in 5% probability level. Dry forage yield and dry weight of ear to total forage yield had significant effect under double interaction of sowing date × plant density and plant density × seed pre-treatment in 1% probability level (Table 1). With delay cropping in second year dry weight of single plant, dry forage yield and dry weight of ear to total forage yield had significantly decreased, but dry weight of leaf and stem to total forage yield in this year with delay in cropping was significantly increased. With increase plant density dry forage yield equivalent to 10218 kg/ha and dry weight of leaf to total forage yield (0.133) had increased. Dry weight of stem to total forage yield 0.36 in PEG_{8000} was the least, but dry weight of ear to total forage yield 0.52 was the most (Table 2). In both years with delay in cropping dry weight of single plant was decreased. In second year with delay in cropping dry weight of ear to total forage yield 0.37 was decreased and dry weight of leaf and stem to total forage yield equivalent to 0.15 and 0.49 had increased, respectively. As the most dry forage yield equivalent to 12430.05 kg/ha was produced in 28 July and 9 plants per square meter (Table 3). With attention to Table 4 maximum dry weight of single plant and dry weight of ear to total forage yield and minimum dry weight of stem to total forage yield was observed for 28 July and different pre-treatment levels. As dry weight of single plant was the most in 7 plants per square meter with hydro-priming (138.87 g) and 9 plants per square meter with seed pre-treatment on PEG_{8000} and KNO_3 (138.67 and 138.98 g) respectively, but forage yield was the most with increase plant density and non pre-treatment 10959.79 kg/ha with seed pre-treatment with KNO_3 (10458.66 kg/ha). As maximum dry weight of stem to total forage yield and dry weight of ear to total forage yield had observed in 7 plants per square meter with seed pre-treatment on KNO_3 (0.41) and 9 plants per square meter with seed pre-treatment on PEG_{8000} equivalent to 0.53 (Table 4). Hunter et al., (1974) reported shorter dent corn plants as photoperiod decreased; however, temperature was held constant and the same authors show interactions between photoperiod and temperature on crop development and growth. Williams and Lindquist (2007) showed that an 83-d sweet corn hybrid grew 9% taller when planted the third week of June in Illinois compared with the first week of May. Data in the present study indicated that a popular sweet corn hybrid, 'BC0805', can grow 13% to 23% taller when planted near the end of the season compared with the earliest planting dates of the north central United States. Delayed planting also resulted in plants with fewer leaves and slower rates of leaf appearance. Plants grown in the mid-June and early July planting dates averaged 11% to 25% fewer maximum leaves compared with earlier planting dates. In addition, leaf appearance rate (m) generally decreased by as much as 22% with later planting dates (Martin and Williams, 2008). Yield loss from planting full-season dent corn hybrids after optimal dates is well known (Benson, 1990; Darby and Lauer, 2002; Lauer et al., 1999; Swanson and Willhelm, 1996). Yield of late June-planted sweet corn was comparable to early May planting in 1 year in Urbana, IL, but in another year, yield was reduced proportional to the lower water supply in the late June planting (Williams, 2006). Narrow row corn has been advocated for enhancing grain production in corn due to less weed competition and better resource (soil water, solar radiation, and nutrients) utilization (Sharratt and McWilliams, 2005). Andrade *et al.* (2002) found that yield response to decreased row spacing was negatively correlated to radiation interception at pollination time with the wider spacing.

Conclusion:

Although, grain corn and silage corn cropping in the Mazandaran province in spring and summer cropping is common, but silage corn cropping in non logging land after rice harvesting in summer delay cropping in this study was considered. Therefore, in this second year experiment silage corn cropping in summer delay cropping in July with 90000 plants per hectare was possible and for sure increase product must seed pre-treatment with pure water (hydro-priming) before of planting, because due to faster growth and for increase dry weight of ear to total forage yield seed pre-treatment with PEG_{8000} in 10% concentration was recommended.

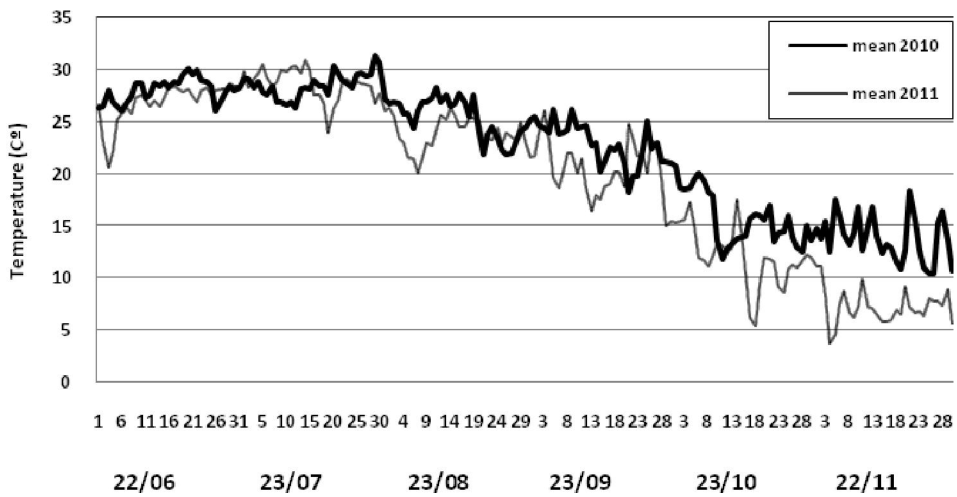

Figure 1. Mean daily temperature in two growing seasons at Gharakheil in 2010-2011.

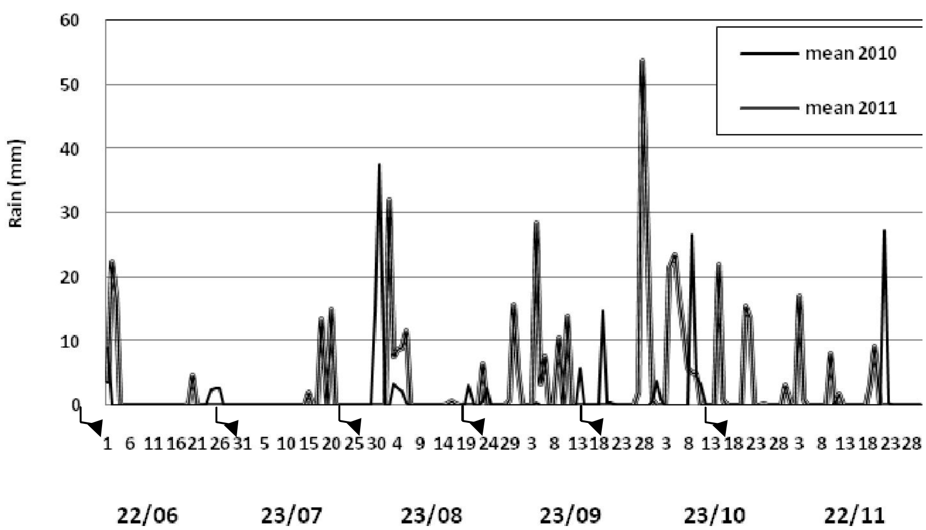

Figure 2. Mean daily rain in two growing seasons at Gharakheil in 2010-2011.

Table 1. Summary of combined analysis of variance for different characteristics of Silage corn.

S.O.V	DF	Dry weight of single plant	Dry forage Yield	Dry weight of leaf ratio To total	Dry weight of stem ratio To total	Dry weight of ear ratio To total	Ear diameter	Ear length	Ear height	Stem diameter	Days to coleoptiles emergence	Days to first male inflorescence emergence
Year (Y)	1	2228.03*	9959011.6*	229.007**	2473.15**	4101.35**	6.32**	30.65**	84.18^{ns}	0.0001^{ns}	20.06**	225.81**
Y/R	3	780.80	4187018.9	18.78	137.95	248.26	0.04	2.46	52.94	0.01	1.58	4.96
Planting date (pd)	1	66085.66**	379283532.9**	6.36**	3284.15**	3587.15**	14.08**	41.998**	5307.08**	2.18**	102.73**	111.25**
Y × pd	1	2090.05*	9187239.4^{ns}	95.10**	246.31**	644.45**	0.53*	32.26**	99.41^{ns}	0.002^{ns}	133.40**	7.67^{ns}
Error	6	1099.54	7716279.5	8.51	78.43	135.10	0.22	6.93	363.39	0.03	2.94	12.23
Plant density (pp)	1	91.07^{ns}	153847440.7**	5.64*	1.16^{ns}	11.86^{ns}	0.001^{ns}	10.47**	960.97**	0.04^{ns}	8.34**	11.68^{ns}
Y × pp	1	18.89^{ns}	21687.4^{ns}	4.11^{ns}	0.01^{ns}	3.72^{ns}	0.05^{ns}	0.01^{ns}	2.24^{ns}	0.00002^{ns}	0.42^{ns}	0.01^{ns}
Pd × pp	1	436.71^{ns}	30823035.9**	5.03^{ns}	1.60^{ns}	12.21^{ns}	0.11^{ns}	0.01^{ns}	129.36^{ns}	0.04*	0.17^{ns}	0.68^{ns}
Y × Pd × pp	1	116.22^{ns}	78843.7^{ns}	0.41^{ns}	0.99^{ns}	2.67^{ns}	0.01^{ns}	0.51^{ns}	0.31^{ns}	0.05*	1.84^{ns}	1.12^{ns}
Error	12	911.85	4453346.1	2.96	18.84	27.90	0.07	0.78	163.03	0.02	1.43	11.58
Seed priming (sp)	3	63.12^{ns}	2561614.8^{ns}	0.44^{ns}	73.28**	81.08**	0.17^{ns}	1.10^{ns}	123.39^{ns}	0.005^{ns}	4.38*	12.53*
Y × sp	3	287.97^{ns}	1086110.0^{ns}	2.37^{ns}	10.81^{ns}	17.51^{ns}	0.04^{ns}	0.85^{ns}	2.34^{ns}	0.007^{ns}	0.55^{ns}	0.26^{ns}
Pd × sp	3	940.69*	29946221.9^{ns}	1.43^{ns}	35.18*	47.79*	0.06^{ns}	1.24^{ns}	159.53^{ns}	0.005^{ns}	0.66^{ns}	0.81^{ns}
Pd × sp	3	89.45^{ns}	690766.6^{ns}	0.50^{ns}	9.63^{ns}	13.91^{ns}	0.12^{ns}	0.30^{ns}	106.67^{ns}	0.001^{ns}	2.09^{ns}	0.72^{ns}
Pp × sp	3	990.57*	7335207.0*	3.33^{ns}	41.72*	67.47**	0.02^{ns}	0.28^{ns}	24.41^{ns}	0.004^{ns}	0.89^{ns}	3.86^{ns}
Y × pp × sp	3	133.70^{ns}	693996.1^{ns}	0.22^{ns}	3.94^{ns}	4.58^{ns}	0.003^{ns}	0.71^{ns}	11.998^{ns}	0.02^{ns}	1.93^{ns}	6.77^{ns}
pd × pp × sp	3	198.54^{ns}	971874.7^{ns}	1.95^{ns}	27.01^{ns}	31.92^{ns}	0.18^{ns}	5.18**	37.70^{ns}	0.01^{ns}	0.73ns	2.22^{ns}
Y × pd × pp × sp	3	857.40^{ns}	4318201.4^{ns}	0.18^{ns}	12.83^{ns}	11.24^{ns}	0.10^{ns}	3.23*	59.004^{ns}	0.02^{ns}	0.05^{ns}	1.87^{ns}
Error	72	331.86	2364753.1	1.21	13.03	15.88	0.09	1.06	84.88	0.01	1.10	4.07
C.V. (%)	_	13.62	16.86	9.10	9.52	7.98	8.13	3.71	7.83	5.86	14.02	3.21

**and *: Significant at the 5% and 1% probability levels, respectively; ns: Non-Significant

Table 2. Mean comparison of different agronomic characteristics of Silage maize in different treatments

Treatment	Dry weight of single plant (g)	Dry forage yield (kg/ha)	Dry weight of leaf ratio to total	Dry weight of stem ratio to total	Dry weight of ear ratio to total	Ear diameter (cm)	Ear length (cm)	Ear height (cm)	Stem diameter (cm)	Days to coleoptiles emergence (days)	Days to first male inflorescence emergence (days)
Year											
2010	137.92 a	9400.6 a	0.11 b	0.34 b	0.56 a	3.82 a	28.17 a	118.50 a	1.73 a	7.09 b	61.54 b
2011	129.57 b	8842.7 b	0.13 a	0.42 a	0.44 b	3.37 b	27.20 b	116.88 a	1.73 a	7.89 a	64.20 a
Planting date											
July 28	156.47 a	10843.0 a	0.118 b	0.33 b	0.55 a	3.92 a	28.26 a	124.13 a	1.86 a	8.39 a	61.94 b
August 12	111.02 b	7400.2 b	0.123 a	0.43 a	0.45 b	3.26 b	27.11 b	111.25 b	1.60 b	6.59 b	63.80 a
Plant density											
70000 plant per hectare	132.90 a	8025.3 b	0.118 b	0.38 a	0.50 a	3.60 a	27.97 a	114.95 b	1.75 a	7.74 a	63.17 a
90000 plant per hectare	134.59 a	10218.0 a	0.123 a	0.38 a	0.50 a	3.59 a	27.40 b	120.43 a	1.71 a	7.23 b	62.57 a
Seed priming											
Control	135.11 a	9511.4 a	0.12 a	0.38 ab	0.50 bc	3.64 a	27.61 a	117.28 a	1.72 a	7.30 ab	62.59 ab
H_2O	132.04 a	8913.0 a	0.12 a	0.38 bc	0.50 ab	3.64 a	27.63 a	118.91 a	1.72 a	7.06 b	62.14 b
PEG $_{(8000)}$	133.18 a	8912.1 a	0.12 a	0.36 c	0.52 a	3.49 a	27.55 a	115.09 a	1.73 a	7.84 a	63.53 a
KNO_3	134.65 a	9150.0 a	0.12 a	0.40 a	0.48 c	3.60 a	27.96 a	119.47 a	1.75 a	7.75 a	63.22 a

Mean, in each column and for each factor, followed by at least one letter common are not significantly different at the 5% level of probability – Using Duncan's Multiple Range Test.

Table 3. Mean Year × Planting date interaction and Planting date × Plant density interaction for some agronomic characteristics

Year	Planting date	Ear Diameter (cm)	Dry weight of single plant (g)	Dry weight of leaf ratio To total	Dry weight of stem ratio To total	Dry weight of ear ratio To total	Days to coleoptiles emergence (days)	Planting date	Plant density	Dry forage yield (kg/ha)
2010	July 28	4.08 a	156.60 a	0.11 bc	0.30 c	0.59 a	6.97 bc	July 28	70000 plant per hectare	9255.96 b
	August 12	3.55 b	119.23 b	0.10 c	0.37 b	0.53 a	7.22 b		90000 plant per hectare	12430.05 a
2011	July 28	3.77 b	156.33 a	0.12 b	0.36 b	0.52 a	9.80 a	August 12	70000 plant per hectare	6794.64 d
	August 12	2.97 c	102.81 b	0.15 a	0.49 a	0.37 b	5.97 c		90000 plant per hectare	8005.85 c

Mean, in each column, followed by at least one letter common are not significantly different at the 5% level of probability – Using Duncan's Multiple Range Test.

Table 4. Mean Planting date × Seed priming interaction and Plant density × Seed priming interaction for some agronomic characteristics

Planting date	Seed priming	Dry weight of single plant (g)	Dry weight of stem ratio To total	Dry weight of ear ratio To total	Plant population	Seed priming	Dry weight of single plant (g)	Dry forage yield (kg/ha)	Dry weight of stem ratio To total	Dry weight of ear ratio To total
July 28	control	155.42 a	0.33 d	0.55 a	70000 plant per hectare	control	134.72 a	8062.96 d	0.38 bc	0.50 abc
	H_2O	159.76 a	0.33 d	0.55 a		H_2O	138.87 a	8522.76 cd	0.36 c	0.52 ab
	PEG $_{(8000)}$	149.41 a	0.32 d	0.56 a		PEG $_{(8000)}$	127.69 a	7674.04 d	0.37 bc	0.52 ab
	KNO_3	161.27 a	0.33 d	0.55 a		KNO_3	130.32 a	78.41.43 d	0.41 a	0.47 c
August 12	control	114.80 b	0.44 ab	0.44 cd	90000 plant per hectare	control	135.50 a	10959.79 a	0.69 ab	0.49 bc
	H_2O	104.31 b	0.42 bc	0.45 bc		H_2O	125.20 a	9303.23 bc	0.39 ab	0.48 c
	PEG $_{(8000)}$	116.95 b	0.40 c	0.48 b		PEG $_{(8000)}$	138.67 a	10150.12 ab	0.36 c	0.53 a
	KNO_3	108.03 b	0.46 a	0.41 d		KNO_3	138.98 a	10458.66 a	0.39 ab	0.49 bc

Mean, in each column, followed by at least one letter common are not significantly different at the 5% level of probability – Using Duncan's Multiple Range Test**.**

Table 5. Mean Year × Planting date × Plant density × Seed priming interaction for some agronomic characteristics.

Year	Planting date	Plant density	Seed priming	Ear length (cm)	Year	Planting date	Plant density	Seed priming	Ear length (cm)
2010	July 28	70000 plant per hectare	control	28.56 a-d	2011	July 28	70000 plant per hectare	control	27.29 c-h
			H_2O	28.88 a-d				H_2O	28.21 a-e
			PEG $_{(8000)}$	28.16 a-e				PEG $_{(8000)}$	28.75 a-d
			KNO_3	28.71 a-d				KNO_3	29.73 a
		90000 plant per hectare	control	28.23 a-e			90000 plant per hectare	control	29.03 abc
			H_2O	27.48 b-h				H_2O	27.64 b-g
			PEG $_{(8000)}$	27.68 b-h				PEG $_{(8000)}$	27.18 d-h
			KNO_3	28.26 a-e				KNO_3	28.34 a-e
	August 12	70000 plant per hectare	control	28.39 a-e		August 12	70000 plant per hectare	control	27.18 d-h
			H_2O	28.01 a-e				H_2O	26.24 f-i
			PEG $_{(8000)}$	29.10 ab				PEG $_{(8000)}$	25.87 hi
			KNO_3	27.82 b-f				KNO_3	26.65 e-h
		90000 plant per hectare	control	27.26 c-h			90000 plant per hectare	control	24.93 i
			H_2O	28.57 a-d				H_2O	25.98 ghi
			PEG $_{(8000)}$	27.62 b-g				PEG $_{(8000)}$	26.02 ghi
			KNO_3	28.07 a-e				KNO_3	26.09 f-i

Mean, in each column, followed by at least one letter common are not significantly different at the 5% level of probability – Using Duncan's Multiple Range Test.

Table 6. Mean Year× Planting date× Plant density interaction for some agronomic characteristics.

Year	Planting date	Plant density	Stem diameter (cm)
2010	July 28	70000 plant per hectare	1.88 a
		90000 plant per hectare	1.84 a
	August 12	70000 plant per hectare	1.61 b
		90000 plant per hectare	1.58 b
2011	July 28	70000 plant per hectare	1.84 a
		90000 plant per hectare	1.88 a
	August 12	70000 plant per hectare	1.66 b
		90000 plant per hectare	1.55 b

Mean, in each column, followed by at least one letter common are not significantly different at the 5% level of probability – Using Duncan's Multiple Range Test.

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