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COMPARISON OF QUALITATIVE AND QUANTITATIVE PERFORMANCE OF FORAGE CROPS MAIZE, SORGHUM AND AMARANTH AS AFFECTED BY PLANTING DENSITY AND DATE IN FARS PROVINCE, IRAN

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ABSTRACT
The Effects of planting date and density on quantitative and qualitative performance of three grass species were investigated in year 2013 at Marvdasht area of Fars province. Treatments included plant species (forage maize, SC 704, forage sorghum cultivar Speed feed and a new forage crop, amaranth), plant density (66000, 83000 and 110000 plants per hectare) and planting date (June 22, July 6, July 21). The experiment was conducted as split-plot in a complete randomized design with 3 replications. Combined analysis of variance indicated that, plant species, planting density and date significantly affected hay production, stalk diameter, number of leaves per plant, and fiber content, calcium and iron content, so that the highest hay production (11279.70 g m^{-2}), leaf count (393.38 leaves per plant), grain protein content (14.85%), iron (446 mg kg^{-1} dry matter) and calcium (3.66%) content and stalk diameter (7.16 cm)and the lowest fiber content (9.44%) was obtained in amaranth in 66000 plant per hectare plant density on July 6 sowing, while the minimum hay production (1269.97 g m^{-2}), stalk diameter (1.75 cm), leaf count (11.5 per plant), calcium content (0.378%) and the maximum fiber content (26.39% DM) were found in sorghum. The results of this experiment showed that amaranth at 66000 of plants per hectare density and sowing date of July 6 could be recommended for Fars province, Iran.

KEYWORDS: Calcium, Fiber, Iron, Protein, Yield.

INTRODUCTION
Due to increase in population there is a growing demand for livestock production and hence forage plants; nevertheless in Iran forage production is rather poorly considered compared with other crops. This insufficient attention to qualitative and quantitative improvement of forage crops has brought about a decrease in production of meat, dairy and other livestock outputs. On the other hand, pressure of livestock on pastures has led to destruction of vegetation and soil erosion. As a result a great part of the country deserts have converted to infertile salty lands. Sowing date had a prominent effect on various stages of plant growth and development and therefore is amongst the most important factors affecting maximum performance of plant. Favorable sowing time leads to optimal utilization of climatic factors and agreement of flowering period with proper temperature which bring about increased production both qualitatively and quantitatively (Khajehpour, 2004). Planting date is the most important factor affecting the entire physiological and morphological properties of the plant. It influenceslength of vegetative and reproductive stages, plant harvesting and performance (Hasanzadeh, 1991).

The production capability of maize plant is different depending on planting date (Morris et al., 2000). A study of planting date in south eastern Antalya indicated that maximum corncob production (17751 kg ha^{-1}) gained with planting on July 25, while the lowest (1824 kg ha^{-1}) was that of April 25; the corncob yield decreased as a result of advancing planting date (between April 25 and June 25), and the optimal planting date for south eastern Antalya was from June 25 to July 25 (Oktem et al., 2004). Ayeneband et al. (2010) showed that planting date significantly affected most qualitative and quantitative traits of forage amaranth; cultivar Mercado produced more hay (31 tons ha^{-1}) when cultivated on July 6 (compared with June 22 and July 23). Bagheri and Baluchi (2010) studied the effect of planting date on qualitative and quantitative characteristics of nine varieties of grain sorghum in Yasuj area and found that it has a significant effect on performance and performance components as well as physiological and morphological properties of the plant; planting date June 5 (compared to May 20 and June 20) resulted in maximum performance (863 g m^{-2}). Amongst other important factors affecting plant performance is plant density per surface unit. In order to fully exploit natural resources we need to optimize the density per surface unit (Mazaheri et al., 2004).

The maximum performance per surface unit is obtained when within- and between-plant competition is minimized so that plant would utilize resources for growth most efficiently (Khajehpour, 2004). Within-plant competition greatly influences plant traits (Demotes and Pellerin, 1992). It was shown that increasing the plant density ingrain maize, decreased grain protein content (Sadeghi and Bohrani, 1999). Nirumand et al. (1999) reported that plant density and planting date significantly affected grain protein content of grass pea in Birjandregion, which is postponing sowing date and increasing density led to a fall in protein content of dry matter (DM). Mokhtarpour et al. (2001) compared effect of different planting dates (April 9 and 29, May 19, June 7) and planting densities (45, 55, 65 and 75 thousands per hectare) on sweet corn performance; the maximum wet and dry weight (44200 and 7330 kg/ hectare, respectively) obtained with 75000 plants per hectare, while the protein and fiber content was maximum with 75000 plants per hectare and planting date April 29.

Evaluating the effect of density on plant should be accompanied with planting date because these factors have a significant interaction. Appropriate planting date positively influences performance components and increases grain and dry matter performance. Plant density affects plant performance components as well, such that an optimal density results in a desirable performance (Farnham, 2001). One important limiting factor in animal production and development is supplying forage to feed them; In Iran a great deal of imports comprises forage and forage grains. Hence the necessityto increase forage production increasingly feels vital.

MATERIALS AND METHODS

This study was achieved during summer and fall of 2013, in Fars Province, Marvdasht County, and in two regions. Marvdasht County is located on longitude 52 48' 29" latitude 29 52',with1595 meters above mean sea level; average rainfall during 2013 was 316.8 mm with the long time average of 365 mm per year. Average minimum temperature was 8.7°Celsius and average maximum temperature was 25.7° Celsius. According to Köppen climate classification this region belongs to temperate group. Physico-chemical properties of experimental (30 cm depth) are given in Table 1.

The experiment conducted as split split-plot in a complete randomized design with 3 replications and in two different locations within an agricultural year. Experimental treatments included plant species (forage maize, forage sorghum variety Speedfeed, forage amaranth), planting density (66000, 83000 and 110000 plant per hectare) and planting date (June 22, July 6, July 21).

Fertilizer application was achieved according to the results of soil analysis, the fertilizers composed of ammonium phosphate (300 kg ha^{-1}) and urea (300 kg ha^{-1}); urea was added at three steps. Eeperimental plots were irrigated every 7 days. During the growth period plots were regulary hand weeded. The measured traits included hay yield , stalk diameter, number of leaves per plant, protein content, fiber content, iron and calcium content. To measure quantitative traits like hay yield, stalk diameter and leaf count per pant, plants were randomly samples from each plot, Stalk diameter was measured by Vernier caliper . Number of leaves per plant was counted after they were dried for 72 h in oven at 65° C, to achieve dry biomass. Dried samples were sent to laboratory for qualitative analysis; Percentage of protein, fiber, calcium, and iron content (mg kg^{-1} DM) the collected data were subjected to ANOVA and means were compared with Duncan's test using SAS and MSTATC softwares.

RESULTS AND DISCUSSION

1. Dry hay yield

Combined ANOVA showed that plant species, planting density and planting date affected hay yield ($P < 0.01$, Table 2).

Comparison of hay yield for location, species, density and planting date using Duncan's method is given in Table 3. Effect of location on mean performance of hay was not significant. The best hay yield was that of amaranth plant(5844.43 g m^{-2}), planting density 66,000 plants per hectare (3876.10 g m^{-2}) and planting date July 6 (4726.68 g m^{-2}) (Table 3).

The comparison of means between species, planting density and date in two experimental locations showed that the highest hay yield (average 11279.70 g m^{-2}) obtained from amaranth planted on July 6 with density of 66,000 plants per hectare (Table 4). The lowest hay yield(average 1269.97 g m^{-2}) was that of sorghum planted on July 21 with density of 66,000 plants per hectare (Table 4). Mokhtarpur et al. (2001) compared effect of different planting dates (April 9, 29, May 19, June 7) and densities (45, 55, 65, 75 thousands ha^{-1}) on qualitative and quantitative performance of sweet corn in Golestan province and found that the maximum hay yield gained with 55-65000 plants per hectare planted on April 29. Ayenehband et al. (2005) studied the effect of different planting dates on qualitative and quantitative performance of forage amaranth and reported that the highest hay yield in Ahvaz obtained from sowing on July 6 compared with June 22 and July 23.

2. Stalk diameter

Combined ANOVA indicated that the plant species, planting density and date had a significant effect on stalk diameter ($P < 0.01$, Table 2). Duncan's mean comparison for location, species, density and date (Table 3) showed that the effect of location on stalk diameter was not significant. Amaranth had the thickest stalk (4.39 cm); with 66,000 plants per hectare stalk diameter was the highest (4.00 cm), and planting on July 6, average stalk diameter was the highest with 3.66 cm (Table 3).

Comparison of mean interactions between species, planting density and planting date in both experimental locations showed that the highest stalk diameter (average 7.16 cm) was that of forage amaranth with planting date July 6 and planting density of 66,000 plants per hectare (Table 4). The lowest stalk diameter (average 1.75 cm) was that of sorghum with density of 110,000 plants per hectare planted on July 21 (Table 4). Stalk diameter is a measure of growth that is affected by factors such as planting density; with increasing plant density, stalk diameter is reduced due to severe competition (Ayub et al., 2003). Artega (1991) also reported that with increasing planting density, stalk diameter falls.

In a study at Shirvan region on grain maize, planting date and density had a significant effect on stalk diameter, that is with increasing density and delaying planting date, the diameter of stalk decreased (Rafiyi et al., 1384). Kaul (2008) reported that increasing planting density of amaranth decreased stalk diameter and hay weight. It appears that due to large size and large number of branches and leaves in crop amaranth, lowering planting density leads to more space per plant and decreases between-plant competition which augments stalk diameter and leaf numbers and enhances hay production.

3. Number of leaves per plant

Combined ANOVA revealed that species, planting density and date had a significant influence on number of leaves ($P < 0.01$, Table 2). Comparison of mean number of leaves per plant (Table 3) indicated that number of leaves were not significantly different between two locations; The maximum leaf count was that of amaranth (average 242.83 leaf per plant); With sowing 66,000 plants per hectare average number of leaves (12.79 per plant) was maximum, and planting on July 6, average number of leaves per plant (114.93) was the highest (Table 3).

Comparison of mean interaction between species, planting density, and planting date, in two experimental locations showed that the maximum number of leaves (average 393.38 leaves per plant) obtained from amaranth with planting density of 6000 and planting date July 6, while the lowest number of leaves (average 11.50 leaves per plant) obtained from sorghum planted on June 21 with density of 110,000 plants per hectare (table 4). However following that was maize which in all three planting dates and densities was not significantly different from sorghum planted on July 21 with density of 110,000 plants per hectare (Table 4).

In maize and sorghum, number of leaves is a fairly constant character of every hybrid and is not affected by environmental conditions; nevertheless duration of plant life is affected by temperature, so that a rise in temperature decreases growth stage duration (Nurmohammadi et al., 2001). Rafi'ei and Asgharipour (2005) showed that delaying planting date decreased leaf count per plant. Ayeneband et al. (2004) compared effect of different planting dates (June 22, July 6, July 23) on performance of forage amaranth in Ahvaz region and indicated that delaying planting date decreased leaf count.

4. Grain protein

Plant species, planting density and date affected grain protein content ($P < 0.01$, Table 2). Table 3 shows comparison of mean protein percentage under different treatments; protein content was significantly different in two experimental locations ($P < 0.01$) and was higher in the first location (average 10.034%, Table 3). Comparison of means revealed that the maximum protein percentage (12.12) was that of amaranth. In addition, the protein content (10.80%) was the highest with 66,000 plants per hectare. Planting on July 21 produced the highest protein content (average 10.81%, Table 3). Advancing the planting date would decrease the duration of grain filling with carbohydrates due to late season stresses, which causes a rise in protein content (Nurmohammadi et al., 2001). The maximum protein content (14.85%) obtained from amaranth with 66,000 plants per hectare and planting date July 6 (Table 4). The lowest protein content (6.15%) was that of maize with 110,000 plants per hectare, planted on June 22 (Table 4). Ayeneband et al. (2005) stated that amaranth cultivars were significantly different in protein content; the higher the hay performance, the higher the grain and hay protein content. These authors found that delaying the planting date, lowered hay performance and protein content. These results are in agreement with Myers (1996), Pond (1989) and Stallknecht (1993). Ra'ei et al. (2009) reported that increasing planting density lowered the protein content of forage sorghum. It seems that in high densities, within-species competition for water and minerals as well as stress, lower protein content (Haberle et al., 2008). In corn it was shown that increasing planting density, decreased grain protein content (Sadeghi and Bohrani, 2000). However having the same high planting density, delaying planting date, increased protein content due to shorter period of growth and development and shorter period for grain to be filled with carbohydrates which elevates protein to carbohydrate ration (Nurmohammadi et al., 1380). With higher planting densities, shadows from neighboring plants decreases amount of light penetrated into plants and subsequently a fall in concentration of nitrite reductase leads to failure of nitrogen reduction. In addition as density is raised the competition for processed nutrients, especially nitrogen leads to lower nitrogen per cob and grain which depresses grain protein content (Graybill et al., 1991).

5. Fiber percentage

The effect of species, planting density and date on fiber percentage was significant ($P < 0.01$, Table 2) and the fiber content was also significantly different in the two experimental locations. The fiber content was higher in the second farm (average 16.97%, Table 3). The highest fiber content (average 23.10%) came from sorghum, while the lowest was that of forage amaranth (average 11.50%). The greatest fiber content (average 19.28%) obtained with 110,000 plants per hectare. the highest fiber percentage was also obtained from planting on July 21 (average 18.164%, Table 3). Comparison of mean interactions between treatments indicated that the highest fiber percentage (average 26.29) obtained from planting density 110000 per hectare with sorghum planted on July 21 (Table 4). The lowest fiber content obtained from amaranth (average 9.33%) with planting density of 66000 per hectare, sowed on June 22, followed by the same plant, sowed on July 6 (9.44%, Table 4). According to study of Ayeneband et al. (2006) on forage amaranth in Ahvaz, the lowest fiber content (21.6%) obtained from Mercado cultivar sowed on July 6 compared with June 22 and July 23. Regarding table 4 it appears that in amaranth, increasing planting density and delaying planting date results in higher fiber content. Rabbani et al. (2011) compared two forage amaranth cultivars with forage maize and found that maize produced the highest fiber and soluble carbohydrate content. Increasing planting density reduces qualitative performance of sorghum which declines quality of forage, especially for making silage (Masaoka and Takano, 1985). Most researchers have reported that with higher densities, fiber content is increased and digestibility falls (Cox et al., 2001; Lauer, 1997).

6. Iron content

As combined ANOVA revealed, the effect of plant species, planting density and date on iron content was significant ($P < 0.01$, Table 2). Comparison of mean iron content showed that location, species, planting density and date had a significant effect ($P < 0.01$, Table 3); The iron content was higher in second experimental location (average 221.14 mg kg^{-1} DM). Forage amaranth (325.98 mg kg^{-1} DM), planting density of 66,000 per hectare (267.36 mg kg^{-1} DM) and planting date July 6 (226.901 mg kg^{-1} DM) produced the highest iron content (Table 3). Comparing the mean of interactions between treatments showed that the maximum iron content (446 mg kg^{-1} DM) was that of amaranth with density of 66,000 plants per hectare, sowed on July 6 (Table 4). The minimum iron content produced in maize with 110,000 plants per hectare planted on July 6 (Table 4).

The iron content of forage amaranth grain (7-15 mg $100g^{-1}$ DM) is higher that maize grain (2-3 mg $100g^{-1}$ DM) (Fomsgaard, 2008). Many researchers have reported that the iron content of amaranth plant, especially leaves, is higher than other forages. It has been reported that iron content of amaranth leaves is similar or slightly higher than spinach plant (Svirskis, 2003; Maff, 1990). Iron is a crucial micronutrient for plants (Ksouri et al., 2007). Its deficiency leads to decreased photosynthesis and chlorophyll concentration (Ksouri et al., 2007; Mahmoudi et al., 2005; Thoiron et al., 1999), decreased dry matter of areal parts and root (Yousefi et al., 2009) and changes iron and other metallic elements in plant tissue, all of which affect performance of crop plants. As demonstrated in Table 4 it seems that delaying planting date and increasing the density, depresses the forage iron content.

7. Calcium percentage

According to the results of combined ANOVA, plant species, planting density and date, significantly influenced calcium content of dry matter ($P < 0.01$, Table 2). As demonstrated by comparing mean calcium levels for location, species, planting density and date, the highest calcium level obtained from the second location (average 1.3194%), amaranth plant (average 2.382%), density of 66,000 plants per hectare (average 1.532%) and planting date July 6 (average 1.362%) (Table 3).

Comparing the mean interactions between species, planting density and date in two different locations showed that the highest calcium level (average 3.66%) was that of forage amaranth with density of 66000 plants per hectare, planted on July 21 (Table 4). The lowest level of calcium was that of sorghum, planted on July 6 (average 0.381%) and July 21 (average 0.378%) (Table 4). It has been shown that with increasing planting density from 300,000 t0 400,000 plants per hectare the calcium content of amaranth decreased from 28.77 to 27.38 mg g^{-1} DM (Gregorova et al., 2001). Stordahl (1999) reported that calcium content of forage amaranth was 2.1% which was higher than maize. A comparison of grain chemical composition between forage amaranth and maize revealed that calcium content of maize (5-7 mg 100 g^{-1} DM) was lower than amaranth (160-212 mg 100 g^{-1} DM) (Fomsgaard, 2008). Fazaeli et al. (2007) reported that calcium content of amaranth silage was 1.9% to 2.2%. Calcium has a vital role in structure of cell wall and root development. Delaying the sowing date of millet decreased calcium content of the forage (Soleimani et al., 1386).

CONCLUSION

Selecting optimal planting density and date are amongst influential factors that improve qualitative and quantitative traits of the crop. On one hand, any forage crop should have high dry matter performance, low fiber content and desirable levels of nutrients at time of harvesting to yield good quality fresh forage and hay or properly fermented high quality silage. Due to the fact that leaf count and stalk diameter are important factors in light absorption, photosynthesis and transportation of photosynthetic products across the plant, they play an important role in production of dry matter. On the other hand the demand of growing population for animal products highlights the role of forage plants in animal nutrition. Two initial factors needed to be considered when introducing a plant to cultivation pattern of any region are planting density and date; cultivation date has a prominent effect on length of growth and reproductive periods and quality of nutrients, while planting density acts through intra-species competition and affects nutrient quality within each plant. This experiment was conducted to compare qualitative and quantitative aspects of three forage crops, amaranth, maize and sorghum. The best treatment regarding high hay yield, stalk diameter, leaf count per plant, protein, iron and calcium content and low fiber level was amaranth with density of 66,000 plants per hectare planted on July 6 in conditions of Fars province,Iran and is advisable in similar agricultural and climatic conditions, This plant under mentioned treatments was superior than forage maize and sorghum regarding evaluated traits.

Table1. Macro and microelements content of experimental soil.

a) First location

Element	Ph	Ec	Clay	Silt	Sand	N	P	K	Fe	Zn	Cu	Mn
		ds/m	(%)				mg/kg^{-1}					
Rate	7.73	0.74	41	45	14	0.1	32.8	480	10.8	1.3	1.03	9.7

b) Second location

Element	Ph	Ec	Clay	Silt	Sand	N	P	K	Fe	Zn	Cu	Mn
		ds/m	(%)				mg/kg^{-1}					
Rate	7.9	0.93	39.6	44.2	16.2	0.098	18	400	8.3	0.7	1.94	8.6

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Table 2. Combined analysis of variance of measured traits

MS							d.f	S.O.V
Calcium	Iron	Fiber	Grain protein	Leaf count per plants	Stalk diameter	Dry hay yeild		
1.809013^{**}	14367.01^{*}	1.0975^{*}	7.41125^{**}	$2.30631^{n.s}$	$0.25205^{n.s}$	$1336^{n.s}$	1	**Location**
$0.001136^{n.s}$	$7.307^{n.s}$	$0.02511^{n.s}$	$0.000383^{n.s}$	$2.13^{n.s}$	$0.053803^{n.s}$	$1276.9^{n.s}$	4	**Rep.(location)**
55.51007^{**}	541528.7^{**}	1842.653^{**}	215.0378^{**}	907612^{**}	67.7655^{**}	238194671^{**}	2	**plant**
1.644574^{**}	14634.67^{**}	0.67902^{**}	0.516156^{**}	24.536^{*}	$0.020846^{n.s}$	770073.90^{**}	2	**plant× Location**
0.001032	2.613	0.006783	0.000578	3.79	0.046609	2235.30	8	**Error1**
6.37468^{**}	190679.6^{**}	273.709^{**}	49.69164^{**}	39425.71^{**}	23.2844^{**}	6381485.90^{**}	2	**density**
0.02489^{**}	1492.96^{**}	0.3657^{**}	0.067924^{**}	209.1941^{**}	$0.008346^{n.s}$	119364.80^{**}	2	**density × Location**
1.898515^{**}	13747.34^{**}	21.75219^{**}	0.594727^{**}	31949.87^{**}	4.01364^{**}	12059283.90^{**}	4	**density × plant**
0.02716^{**}	1365.87^{**}	0.2874^{**}	0.14137^{**}	172.1155^{**}	0.091309^{**}	56337.907^{**}	4	**× plant ×Location density**
0.001099	2.224	0.005687	0.000303	8.222	0.017942	2127.80	24	**Error2**
1.716916^{**}	29972.3^{**}	72.5793^{**}	71.1038^{**}	42309.59^{**}	6.632723^{**}	67929699.30^{**}	2	**Sowing date**
0.50975^{**}	5344.943^{**}	1.26081^{**}	1.710896^{**}	894.249^{**}	0.132624^{**}	1619384.30^{**}	2	**Sowing × Location date**
1.831087^{**}	5426.75^{**}	11.08764^{**}	21.99818^{**}	3031.87^{**}	5.111843^{**}	24143533.30^{**}	4	**Sowing date × plant**
0.591935^{**}	3254.67^{**}	0.231337^{**}	0.554132^{**}	850.116^{**}	0.098504^{**}	840540.40^{**}	4	**× plant × location sowing date**
0.073279^{**}	2745.014^{**}	0.82768^{**}	0.357404^{**}	701.593^{**}	0.432232^{**}	1951764.20^{**}	4	**sowing date× density**
0.067515^{**}	627.78^{**}	0.077592^{**}	0.136054^{**}	179.858^{**}	$0.039226^{n.s}$	656407.80^{**}	4	**× density × location sowing date**
0.109447^{**}	2012.59^{**}	1.922083^{**}	1.791148^{**}	528.529^{**}	0.254741^{**}	2405714.90^{**}	8	**plant×density×sowing date**
0.067038^{**}	343.39^{**}	0.378401^{**}	0.08334^{**}	107.782^{**}	0.054022^{*}	700984.40^{**}	8	**× plant × location sowing date × density**
0.001427	2.983	0.007731	0.00064	6.175	0.021621	2022.10	72	**Error3**
3.1117	1.81	1.52045	1.257	2.6645	4.43	1.30	-	**C.V(%)**

ns:Non-significant. * and**: significant at 5% and 1% probability, respectively.

Table 3. Mean comparision of measured traits on plant ,planting density and sowing date in two experimental locations.

Calcium (%)	Iron mg/kg^{-1}) (D.M	Grain protein (%)	Fiber (%)	Leaf count per plants (number)	Stalk diameter (cm)	Dry hay yield (gr/m^{-2})	Treatments	
1.1080^{b}	202.308^{b}	10.034^{a}	16.811^{b}	92.98^{a}	3.351^{a}	669.3476^{a}	first	Location
1.3194^{a}	221.143^{a}	9.606^{b}	16.976^{a}	93.53^{a}	3.273^{a}	412.3482^{a}	second	
0.685^{b}	139.185^{c}	8.557^{c}	16.086^{b}	13.163^{c}	3.385^{b}	2762.370^{b}	corn	Plant
0.572^{c}	170.011^{b}	8.782^{b}	23.097^{a}	23.781^{b}	2.156^{c}	1831.820^{c}	sorghum	
2.382^{a}	325.981^{a}	12.120^{a}	11.497^{c}	242.83^{a}	4.393^{a}	5844.431^{a}	amaranth	
1.532^{a}	267.36^{a}	10.796^{a}	14.812^{c}	121.794^{a}	4.001^{a}	3876.107^{a}	66000	Density (Plant/ha^{-1})
1.259^{b}	218.685^{b}	9.785^{b}	16.585^{b}	89.920^{b}	3.238^{b}	3296.323^{b}	83000	
0.849c	149.129c	8.879c	19.283a	68.063c	2.694c	3266.192^{c}	110000	
1.262^{b}	223.69^{b}	8.562^{c}	15.893^{c}	103.1880^{b}	3.314^{b}	3158.363^{b}	June22	Sowing date
1.362^{a}	226.901^{a}	10.088^{b}	16.623^{b}	114.933^{a}	3.66^{a}	4726.680^{a}	July6	
1.016^{c}	184.585^{c}	10.809^{a}	18.164^{a}	61.657^{c}	2.960^{c}	2553.580^{c}	July21	

Means in each column followed by similar letter(s) are not significantly different at 5% probability level using Duncan,s Multiple Range Test

Table 4. Mean comparision of interaction effects between plant × density × sowing date on measured traits in two experimental locations.

measured traits							Treatments		
Calcium (%)	Iron (mg/kg^{-1} D.M)	Fiber (%)	Grain protein (%)	Leaf count per plants (number)	Stalk diameter (cm)	Dry hay yeild (gr/m^{-2})	Sowing date	Density (Plant/ha^{-1})	**plant**
0.8083^{k}	218.83^{j}	11.26^{u}	7.48^{u}	13.33^{n}	3.93^{e}	3073.13^{k}	June22	66000	**Corn**
0.783^{k}	225^{h}	12.06^{r}	8.48^{p}	13.66^{n}	3.96^{e}	2957.40^{L}	July6	66000	
0.978^{i}	145.5^{q}	16.31^{m}	12.10^{d}	12.66^{n}	3.73^{f}	1990.27^{r}	July21	66000	
0.712^{L}	177.93^{o}	13.85^{o}	6.65^{w}	13.38^{n}	3.51^{g}	3059.17^{k}	June22	83000	
0.578^{o}	127.5^{s}	14.58^{n}	8.22^{q}	13.33^{n}	3.30^{h}	2869.80^{m}	July6	83000	
0.677^{Lm}	112.5^{t}	16.99^{L}	11.23^{j}	12.80^{n}	3.45^{gh}	2159.03^{q}	July21	83000	
0.6363^{nm}	103.06^{v}	18.79^{k}	6.15^{x}	13.58^{n}	2.93^{i}	3271.59^{j}	June22	110000	
0.4945^{p}	67.66^{x}	19.60^{j}	7.65^{s}	13.50^{n}	2.81^{i}	3092.47^{k}	July6	110000	
0.50433^{p}	74.66^{w}	21.29^{h}	9.04^{n}	12.20^{n}	2.81^{i}	2388.47^{o}	July21	110000	
0.913^{j}	206.66^{k}	20.35^{i}	8.22^{q}	31.93^{k}	2.450^{jk}	1430.83^{tu}	June22	66000	**sorghum**
0.80083^{K}	204.66^{L}	21.90^{g}	10.16^{L}	38.66^{j}	2.51^{jk}	2311.07^{p}	July6	66000	
0.593^{no}	197.1^{m}	22.64^{e}	11.29^{i}	17.66^{m}	2.36^{kL}	1269.97^{w}	July21	66000	
0.583^{o}	195.66^{m}	$21/89^{g}$	7.51^{t}	26.50^{L}	2.26^{L}	1480.53^{t}	June22	83000	
0.506^{p}	190.56^{n}	$22/54^{f}$	9.001^{o}	29.60^{k}	2.21^{L}	2488.75^{n}	July6	83000	
0.517^{p}	130.16^{r}	24.06^{c}	9.64^{m}	13.91^{n}	2.01^{m}	1365.02^{v}	July21	83000	
0.479^{p}	152.38^{p}	23.241^{d}	6.96^{v}	19.083^{m}	1.92^{nm}	1619.59^{s}	June22	110000	
0.381^{q}	144.76^{q}	24.83^{b}	7.72^{r}	25.167^{L}	1.90^{nm}	3101.70^{k}	July6	110000	
0.378^{q}	108.16^{u}	26.39^{a}	8.50^{p}	11.50^{n}	1.75^{n}	1418.93^{u}	July21	110000	
3^{c}	392.5^{b}	9.33^{x}	12.05^{e}	343.50^{b}	5.30^{b}	6079.73^{d}	June22	66000	**amaranth**
3.666^{a}	446^{a}	9.44^{w}	14.851^{a}	393.38^{a}	7.16^{a}	11279.70a	July6	66000	
2.24^{e}	370^{d}	9.97^{v}	12.52^{c}	231.33^{e}	4.583^{d}	4492.87^{e}	July21	66000	
2.717^{d}	342.33^{e}	11.67^{t}	11.33^{h}	277.33^{d}	3.96^{e}	4400.63^{f}	June22	83000	
3.05^{b}	390^{c}	11.74^{t}	12.811^{b}	284.750^{c}	5.05^{c}	7720.02^{b}	July6	83000	
1.99^{f}	301.5^{f}	11.92^{s}	11.66^{g}	137.66^{h}	3.36^{gh}	4123.90^{g}	July21	83000	
1.514^{g}	223.83^{h}	12.63^{q}	10.68^{k}	190.042^{g}	3.53^{g}	4010.05^{h}	June22	110000	
2^{f}	246^{g}	12.88^{p}	11.89^{f}	222.33^{f}	4.016^{e}	6719.17^{c}	July6	110000	
1.25^{h}	221.66^{i}	13.86^{o}	11.28^{i}	105.167^{i}	2.55^{j}	3773.77^{i}	July21	110000	

Means in each column followed by similar letter(s) are not significantly different at5% probability level using Duncan,s Multiple Range Test

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