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In the name of Allah

INFLUENCES OF NITROGEN, PHOSPHORUS, AND POPULATION DENSITY ON YIELD AND N, P, AND K CONCENTRATIONS OF FORAGE CORN[1]

A. Kashirad and D. Palangafkan[2]

ABSTRACT

Fertilization practice and plant population are among the major factors involved in corn (*Zea mays* L.) production. Neveh yea1 170, a long summer full season corn, was grown at two field locations (Bajgah and Kooshkak Agricultural Experiment Stations) near Shiraz. The experimental design was split-split-plot with four replications. The main treatments were N rates of 100, 200, and 300 kg/ha. The sub-treatments were P levels of 25, 50, and 100 kg/ha and the sub-sub treatments were plant populations of 44444, 53333, and 66666 plants per hectare. In both locations, the yield of corn was mainly affected by plant population and N level. There was no significant effect of plant population x N interaction on corn yield. Maximum yield was obtained at the maximum density and this increase

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اثرازت ،فسفروتراکم‌بوته‌روی عملکرد ومیزان ازت ،فسفروپتاس درت علوفه‌ای

احمدکاشی رادودار یوش پلنگ افکن
بترتیب استادسابق بخش خاکشناسی
وسرپرست سابق ایستگاه تحقیقاتی
دانشکده‌کشاورزی دانشگاه شیراز

خلاصه

درتولیددرت علوفه‌ای،کوددهی وتراکم بوته‌ازعوامل مهم‌بشمارمیروند. رقم نوه‌یا ر۱۷۰ که‌دیررس واحتیاج به تابستان طولانی داردردرومحل مختلف (ایستگاههای تحقیقاتی باجگاه وکوشکک) درنزدیکی شیرازکشت گردیدند.طرح آزمایشی عبارت ازکرتهای دوبارخرد شده‌باچهارتکرار،تیمارهای اصلی میزانهای ازت (۱۰۰، ۲۰۰ و۳۰۰کیلوازت درهکتار)،تیمارهای فرعی مقادیرفسفر (۲۵، ۵۰ و ۱۰۰ کیلوگرم‌درهکتار)وتیمارهای فرعی فرعی تعدادبوته (۴۴۴۴۴، ۵۳۳۳۳و ۶۶۶۶۶ بوته‌درهکتار)بود.درهردومحل، تراکم‌بوته ومقادیرازت باعث افزایش عملکردگردید،حال آنکه اثرمتقابل تراکم بوته وازت برروی عملکردرت معنی دارنبود.حداکثرعملکردبا بالاترین تراکم بوته بدست‌آمدواین افزایش‌عملکردبا افزایش غلظت ازت در بافتهای گیاهی همراه‌بود.اثرات ازت، فسفروتراکم‌بوته‌برروی غلظت فسفرو پتاسیم‌درت دردومحل مختلف یکسان نبود. درایستگاه‌تحقیقاتی باجگاه،غلظتهای فسفروپتاسیم با افزایش مقادیرازت زیادشددرحالیکه درایستگاه‌تحقیقاتی کوشکک،تیمارهای یادشده‌برروی غلظت

1. Contribution from the Department of Soil Science, College of Agriculture, Shiraz University, Shiraz, Iran. This research was supported by Shiraz University Agricultural Research Center. Received 25 July 1978.

2. Former Professor of Soil Science and former Farm Manager, respectively.

in yield was associated with N increase in plant tissues. Effects of N, P, and plant population on P and K concentrations of corn plant were not similar in both locations. At Bajgah, the P and K concentrations were increased by increasing N application, while at Kooshkak, there was little or no effect on P and K concentrations of plants. In general, the corn hybrid used in this experiment showed to be capable of producing higher yield as compared to other cultivars grown in Iran.

فسفروپتاسیم اثرنا چیزی داشتند .بطور کلی ،ذرت دورگه مورداستفاده درایـــن آزمایش دارای قابلیت تولیدعملـــرد بیشتری درمقایسه باسایرارقام متداول درایران میباشد.

INTRODUCTION

Selection of hybrid corn seed is one of the most difficult management problems facing the farmers in the corn growing areas of Iran. There is a wide range of differenc in agronomic and yield characteristics of hybrid corn imported from various parts of the world. Among these hybrids, Neveh yaar 170, a long summer full-season corn, has received more attention for its high yielding ability under irrigation in the Fars province of Iran. Application of N and P fertilizers have been practiced as the required supplement to most soils of this area. The assessment of adequate supplies of these elements together with the optimum rate of planting would play a major role in the improvement of corn production of the area.

Several studies have shown increases in grain yield with increasing corn population up to 60000 and 70000 plants per hectare (2, 9, 12, 14). Genter (6) found that planting rates over a range of 19800 to 46900 plants per hectare did not always affect silage yields, but when difference did occur, yield increased with increasing planting rates up to 46900 plants per hectare. Rutger and Crowder (10) in a study with six hybrids and populations from 40000 to 80000, reported that the highest silage yields were obtained at 70000 and 80000 plant per hectare. Seems and Huber (11) suggested that true yields attributable to fertilizer application often can not be measured because of inadequate stand. Practically, all studies involving

population and fertility treatments show that the effect of rate of planting on yield is much greater at higher than at lower fertility levels (3, 5, 8, 13).

The purpose of this experiment was to determine the response of a corn hybrid (Neveh yaar 170) under various rates of planting, and N and P fertilization.

MATERIALS AND METHODS

The experiment was conducted at two locations, Bajgah and Kooshkak Agricultural Experiment Stations, located at 15 and 90 km north of Shiraz, Iran, respectively. The soils of the two locations were classified as Clacixerollic Xerochrept. Some physical and chemical properties of these soils are given in Table 1. Prior to planting, the experimental field was divided into plots of 4.5 by 10 m, with 5

Table 1. Some physical and chemical properties of soils used in the experiments.

Soil property	Soils	
	Bajgah	Kooshkak
Texture	Silty clay	Clay loam
pH (saturated paste)	7.7	7.6
EC_e saturated ext. (mmhos/cm)	0.44	0.78
$CaCO_3$ equivalent (%)	43.7	46.44
Organic matter (%)	2.08	2.03
Total N (%)	0.09	0.07
$NaHCO_3$-extractable P (ppm)	25	20
NH_4OAc-extractable K (ppm)	655	327

rows 75 cm apart. The experimental design was a split-split-plot with four replications. The main-plot treatments were N rates of 100, 200, and 300 kg/ha applied as urea. Half of the nitrogen was side-dressed at planting time and the rest when corn plants were about 50 to 60 cm in height. The sub-plot treatments were P levels of 25, 50, and 100 kg/ha applied as triple superphosphate and the sub-sub treatments were plant populations of 44444, 53333, and 66666 plants per hectare.

Planting was done in mid-May by sowing the seeds 5 cm deep and 20, 25, and 30 cm apart within the row which resulted in populations of 44444, 53333, and 66666 plants per hectare, respectively. Four seeds were placed in each hole and plants were thinned to one after attaining a height of about 10-15 cm. Fertilizer treatments were side-dressed after planting. Irrigation was practiced once a week, using siphons in each furrow. Weeds were controlled by hand hoeing during the growing season. The corn was harvested on September 5 for fresh weight from the center three rows after discarding three plants from the ends of each row. After yield of each plot was determined, plants were chopped and immediately sampled for dry weight determination and chemical analyses. Forage samples were dried at 70°C and ground in a micro-mill to pass a 40-mesh sieve and sampled for N determination and ash analyses. Samples were digested in a mixture of nitric-perchloric-sulfuric acids (5:2:1). Total N was determined by the micro-Kjeldahl method (1); P by vanadomolybdophosphoric yellow method (7); and K by flame photometry. Data were subjected to the analyses of variance and mean comparisons were performed using Duncan's multiple range test at the 1% probability level (4).

RESULTS AND DISCUSSION

The effects of different rates of N and P fertilizers and

plant population on fresh and dry weights of forage corn grown at Bajgah Agricultural Experiment Station are shown in Table 2. For each level of applied N and P, increasing plant population caused an increase in fresh weight of corn. Maximum fresh weight was obtained at the density of 66666 plants/ha. At each level of P, increasing the application of N up to 200 kg/ha increased the fresh weight of corn but the 300 rate did not make any significant change. For each level of applied N, increasing the P rate caused some increase in fresh weight of corn.

The effect of plant population on dry weight at various levels of N and P seems to be more or less similar to that of fresh weight (Table 2). In most instances, with increasing plant population, dry yield of corn was increased and the maximum dry yield was obtained at the maximum density. However, no significant difference in dry yield was observed due to various levels of N and P application.

Table 3 shows the effects of N, P, and plant population on yield of forage corn grown at Kooshkak Agricultural Experiment Station. Increasing plant population at each level of N and P increased fresh and dry yields of corn. Maximum yield was resulted at the highest plant density (66666 plants/ha). For each level of P, increasing N level up to 200 kg/ha resulted in significant increases in fresh and dry yields with no further increase thereafter.

The data in Tables 2 and 3 indicate that in both locations, the yield of corn was mainly affected by plant population and N levels. The lack of response of plants to P application may be due to the fact that both soils had relatively high initial P content (Table 1).

The effects of N and P fertilization and plant population on N, P, and K concentrations of forage corn grown at Bajgah are presented in Table 4. The N concentration was greatly increased by increasing the rate of N application at all P levels and plant densities. In most instances, the effect

Table 2. Effects of N, P, and plant population on yield of forage corn grown at the Bajgah Agricultural Experiment Station.

P added (kg/ha)	Plants/ha	N added (kg/ha)					
		100	200	300	100	200	300
		Fresh wt.			Dry wt.		
		(Ton/ha)					
25	66666	80.3a*	100.8a	101.3a	14.1ab	15.9a	15.5a
	53333	79.8a	94.3b	88.3b	15.5a	15.9a	13.8b
	44444	74.8b	87.5b	85.6b	13.8b	14.9b	14.7ab
Mean		78.3B*	94.2A	91.7A	14.5B	15.6A	14.7B
50	66666	90.5a	100.9a	107.0a	16.8a	17.0a	16.9a
	53333	78.9b	94.3a	87.0b	15.2b	14.6b	14.5b
	44444	72.3b	88.4b	91.5b	14.7b	14.5b	14.2b
Mean		80.6B	94.5A	95.2A	15.6A	15.4A	15.2A
100	66666	87.3a	104.2a	108.2a	15.8a	15.9a	16.9a
	53333	86.7a	93.4b	90.1b	16.0a	14.0b	14.1b
	44444	70.3b	88.2c	95.2b	13.1b	14.5ab	14.8b
Mean		81.4B	95.3A	97.8A	15.0A	14.8A	15.3A

*In each group, means followed by the same letter within columns (lower case letters) and within rows (capital letters) are not significantly different at the 1% probability level (Duncan's test).

Table 3. Effects of N, P, and plant population on yield of forage corn grown at the Kooshkak Agricultural Experiment Station.

P added (kg/ha)	Plants/ha	N added (kg/ha)					
		100	200	300	100	200	300
		Fresh wt.			Dry wt.		
		(Ton/ha)					
25	66666	81.0a*	94.1a	94.0a	21.3a	22.6a	22.2a
	53333	70.0b	81.0b	86.9b	19.0a	21.6a	20.3b
	44444	57.5c	77.6b	79.6c	15.2b	20.8b	21.2ab
Mean		69.6B*	84.2A	86.8A	18.5B	21.7A	21.2A
50	66666	68.4a	93.4a	95.7a	17.4a	21.7a	23.0a
	53333	63.6b	83.0b	84.4b	15.7b	20.2a	22.1b
	44444	62.3b	66.4c	82.3b	15.2b	17.0b	21.2ab
Mean		64.8B	80.9A	87.5A	16.1B	19.6A	22.1A
100	66666	82.6a	90.7a	98.7a	22.6a	22.9a	26.7a
	53333	76.6b	78.0b	83.0b	19.9b	19.9ab	22.0b
	44444	73.1b	67.4c	82.5b	20.0b	18.3b	21.0b
Mean		77.4B	78.7B	88.1A	20.8B	20.4AB	23.2A

*In each group, means followed by the same letter within columns (lower case letters) and within rows (capital letters) are not significantly different at the 1% probability level (Duncan's test).

Table 4. Effects of N, P, and plant population on N, P, and K concentrations of forage corn grown at the Bajgah Agricultural Experiment Station.

P added (kg/ha)	Plants/ha	N added (kg/ha)								
		100	200	300	100	200	300	100	200	300
		N			P			K		
		(%)								
25	66666	0.92a*	1.15a	1.41a	0.13a	0.15a	0.13b	3.81a	4.53a	4.31a
	53333	0.89a	1.33a	1.39a	0.15a	0.14ab	0.15ab	3.24b	3.88b	4.54a
	44444	1.01a	1.18a	1.59a	0.14a	0.13b	0.16a	3.23b	4.07ab	4.23a
Mean		0.94C*	1.22B	1.48A	0.14B	0.14B	0.15A	3.43B	4.16A	4.36A
50	66666	0.83c	0.86b	1.57b	0.13b	0.12b	0.16ab	3.56a	4.13b	4.64a
	53333	1.11b	0.97ab	1.70a	0.16a	0.14a	0.18a	3.16ab	4.55b	4.58a
	44444	1.33a	1.20a	1.69a	0.14b	0.13ab	0.15b	2.78b	5.19a	4.41a
Mean		1.09B	1.01B	1.65A	0.14B	0.13B	0.16A	3.17B	4.62A	4.54A
100	66666	0.96a	0.99b	1.53b	0.15a	0.13b	0.16b	3.50a	3.20b	4.79a
	53333	1.01a	1.17a	1.74a	0.15a	0.14ab	0.17ab	3.20b	4.54ab	4.26ab
	44444	0.91a	1.24a	1.69ab	0.15a	0.15a	0.18a	3.61a	4.85a	3.97b
Mean		0.96B	1.13B	1.65A	0.15B	0.14B	0.17A	3.44B	4.19A	4.34A

*In each group, means followed by the same letter within columns (lower case letters) and within rows (capital letters) are not significantly different at the 1% probability level (Duncan's test).

of P and plant population on N concentration was significant. A similar result was obtained at Kooshkak (Table 5). Comparing the yield data (Tables 2 and 3) and N concentration in plants (Tables 4 and 5), it is evident that yield increase in both locations was associated with nitrogen increase in plant tissues.

The influences of N, P, and plant population on P and K concentrations in corn plants were not similar at the two locations (Tables 4 and 5). At Bajgah, the P concentration was increased significantly only at the highest N rate (300 kg N/ha), while the K concentration was increased at the rates of 200 or 300 kg N/ha at all P levels. At Kooshkak, application of N and P had little or no effect on P and K concentrations in plants (Table 5). The differences in P and K concentrations in plants at the two locations were mainly due to higher P and K contents of the soil at Bajgah (Table 1).

In general, the corn hybrid used in this experiment showed to be capable of producing higher yields under adequate supplies of N and P and high plant populations when compared with other cultivars grown in Iran (Unpublished data by authors).

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Table 5. Effects of N, P, and plant population on N, P, and K concentrations of forage corn grown at the Kooshkak Agricultural Experiment Station.

P added (kg/ha)	Plants/ha	N added (kg/ha)								
		100	200	300	100	200	300	100	200	300
		N			P			K		
		(%)								
25	66666	0.94a*	1.01a	1.32a	0.15ab	0.16a	0.14b	2.55a	2.55a	3.01a
	53333	0.94a	1.10a	1.52a	0.16a	0.16a	0.17a	2.28a	2.50a	2.58a
	44444	0.98a	1.22a	1.47a	0.15b	0.17a	0.17a	2.71a	2.60a	2.68a
Mean		0.95C*	1.11B	1.44A	0.15A	0.16A	0.16A	2.51A	2.58A	2.76A
50	66666	0.95a	1.09a	1.38a	0.16c	0.15b	0.17a	2.72a	2.86a	2.64a
	53333	0.99a	1.08a	1.36a	1.17ab	0.17ab	0.16a	2.87a	2.50a	3.09a
	44444	1.08a	1.07a	1.40a	0.19a	0.18a	0.17a	2.83a	2.50a	2.99a
Mean		1.01B	1.08B	1.38A	0.17A	0.17A	0.17A	2.81A	2.62A	2.91A
100	66666	1.01a	1.11a	1.45a	0.18a	0.15c	0.20a	2.41a	2.82a	2.39a
	53333	0.95a	1.17a	1.47a	0.18a	0.18b	0.18b	2.51a	2.50a	2.63a
	44444	1.11a	1.20a	1.46a	0.17a	0.21a	1.19ab	2.40a	2.56a	2.76a
Mean		1.02B	1.16B	1.46A	0.18A	0.18A	0.19A	2.44A	2.63A	2.59A

*In each group, means followed by the same letter within columns (lower case letters) and within rows (capital letters) are not significantly different at the 1% probability level (Duncan's test).

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