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Effects of Different Row Spacing and Nitrogen Doses on Certain Agronomic Characteristics of Coriander (*Coriandrum sativum* L.)

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Abstract: This study was conducted to compare the relative advantages of different row spacing (20, 30 and 40 cm) and nitrogen applications (0, 30, 60 and 90 kg ha^{-1}) in coriander cultivation in terms of yield and quality characteristics in province of Van, Turkey. Row spacings had similar impact on the average fruit per umbel and umbel per plant but significantly differed for average plant height ($p<0.05$). The number of umbels per plant were significantly higher for N_1 (30 kg N ha^{-1}) those of other doses. There were no significantly differences among nitrogen doses for average plant height and umbel per plant. As an average over nitrogen doses the 30 cm. row spacing was superior to the 20 and 40 cm in terms of seed and biological yields. The 1000 fruit weights were not affected from the row spacings. However, the nitrogen doses differed in their effects on seed yield and showed similar gain in biological yield 1000 fruits weight. No significant effect of N applications was found on the hay yield and yield index in coriander. However, significant effect of row spacings was found for the hay yield ($p<0.05$). The highest was found for the 30 cm. row spacing with an average of 954.10 kg ha^{-1}.

Key words: Row spacings, nitrogen doses, agronomic characteristics

INTRODUCTION

Coriander is probably one of the first spices used by mankind, having been known as early as 5000 BC. Sanskrit writings dating from about 1500 BC also spoke of it. The Romans spread it throughout Europe and it was one of the first spices to arrive in America[1]

Coriander (*Coriandrum sativum* L.) fruit is an annual herb originating from the Mediterranean countries and is nowadays mostly grown in Italy, India, Morocco and Eastern Europe and is commonly known as Coriander, Cilantro, or Chinese Parsley[2]. The latter two are usually used to refer to the plants foliage, while the name Coriander usually refers just to the seeds. During industrialization, the specific chemical compounds of coriander were recognized and identified and these became important as raw materials for industrial use and further processing. The essential and fatty oils of the fruits are both used in industry, either separately or combined[3].

There are two basic varieties; the small seeded type is used largely for essential oil production and the large seeded type is produced for ground and whole seed. Coriander is a winter growing crop that has good potential as an export commodity. Coriander is strongly photosensitive, with flowering triggered by increasing day-length. In addition Coriander does not compete well with weeds, so the less weeds present at sowing, the better. These characteristics of coriander make fertilizers and row spaces critical issues for this plant.

Row spaces and plant density per unit are important in terms of the number of fruits sown per square meter, the weight of 1000 fruits and branching ability of coriander. The Caucasian types have an especially high plasticity and use the available space. These types can either be cultivated with wide distances, allowing mechanical or hand hoeing between the plants[3]. Phosphorus and potassium are nutrients which affect the grain yield of coriander. Applications of nitrogen did not affect the yield in the field trials of[4], where the average yield was 2000 kg ha^{-1}. Heeger[5] advised not to apply more than 20-40 kg N ha^{-1} and Ebert[6] stresses that more than 50 kg N ha^{-1} will favour fungal diseases[3].Studies have indicated that yield in Argentina responds to the application of up to 90 kg N ha^{-1}[1,7]. Nitrogen can retard ripening and cause lodging and coriander is therefore regarded as a low-input crop[1,3,5,8,9].

The distance between rows varies between 0.18 and 0.35 m[1,10,11].

The objectives of the present study was to evaluate the relative advantages of different row spacing and nitrogen application in coriander cultivation in terms of yield and quality characteristics in province of Van, Turkey.

MATERIALS AND METHODS

Experimental location: Field experiments were conducted during the growing season of 1998/1999 in the

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open field at the Agricultural Research Station belonging to the University of Yüzüncü Yıl, Van-Turkey. Experimental site was 1650m above sea level, mean annual rainfall of about 380 mm, temperature range during the cultivation period of 10-30°C. Temperate climatic condition is ruled in the region. The soil has sandy-clay loam texture and low organic matter and nitrogen rich potassium and lime content medium phosphorus and is medium alkaline (pH 8.4)[12].

Experimental design: The experiment was carried out using a split-plot design with three replicates. Main plots were assigned to the row spacing (R_1=20 cm, R_2 = 30 cm, R_3 = 40 cm) and subplots were assigned to the N fertilizer levels (N_0 = 0 kg NH_4SO_4 ha^{-1}, N_1 = 30 kg NH_4SO_4 ha^{-1}, N_2 = 60 kg NH_4SO ha^{-1}, N_3 = 90 kg NH_4SO_4 ha^{-1}). Treatments in main and subplots were assigned randomly. Individual plots were 2x2=4 m^2 and keeping the total plot area constant for all treatments, approximately 144 m^2. Big seeded coriander was used in this study.

Cultural practices: The plots were irrigated to supplement rainfall during the growing season, with a average of 4 irrigations. Weeds were controlled manually. Pre-emergent broadleaf control was done and post-emergent of weed control of broadleaf weeds has been approached with care. Because coriander competes poorly with weeds during early growth, a weed-free seed bed prepared before sowing. The experiment sowing date was on 16 April 1998 with a seeding depth of 2.5 to 4.0 cm. Seeding has been done by hand. Coriander variety big seeded (*Coriandrum sativum* L.) were used as a plant material and harvested all plots on 26 July 1998.

Application of fertilizers: Phosphorus source was triple supper phosphates (46%) and nitrogen source was ammonium sulphates (21%) in this experiment. Phosphorus fertilizer using (triple super phosphate 46% and 60 kg ha^{-1}) were applied together with nitrogenous fertilizer at the sowing date. Four levels of N fertilizers (N_0, N_1, N_2 and N_3) were applied. Each level was applied with showing of coriander. The control treatment was (N_0 = 0 kg NH_4SO_4 ha^{-1}), without fertilizer.

Sampling and statistical analysis: At maturity, 10 plants were randomly selected from each plot and the number of umbels per plant counted. The weight of 1000 fruits was determined and the diameter measured of 400 fruits and so on. Analysis of variance (ANOVA) was performed using the General Linear Model (GLM) in SAS[13] program. Significant differences between means were determined by Duncan's Multiple Range Tests. Before data analysis, data for each trait was checked for outlier detection and for variance analysis assumptions. Relationships between quality tests were examined by Pearson correlation coefficients.

RESULTS AND DISCUSSION

Analysis of the results showed that different row spacings had similar impact on the average fruit per umbel and umbel per plant (Table 1). Differences among row spacings for average plant height, however, were significant ($p<0.05$) and the lowest and highest plant height were for the 20 cm (35.38) and 30 cm (37.89), respectively. The number of umbels per plant were significantly higher for N_2 (60 kg N ha^{-1}) those of other doses (Table 1). There were no significantly differences among nitrogen doses for average plant height and umbel per plant ($p>0.05$). These results not in agreement those of Luayza *et al.*[1] and for the most part coincide with those reported by Rubió *et al.*[14], Luayza *et al.*[1] reported higher yield with wider, Rubió *et al.*[14,15] reported with narrower spacing.

No significant effect of N applications was found on the hay yield and yield index in coriander (Table 3). However, significant effect of row spacings was found for the hay yield ($p<0.05$). The highest was found for the 30 cm row spacing with an average of 954.10 kg ha^{-1}. In consideration of row spacing and N combination, the highest hay yield was obtained from 30 cm row spacing and N_3 and the highest yield index was produces by 40 cm row spacing and N_3. Similar results for the both characteristics were reported many researchers[1,3,16,17].

Results obtained in this study are agreement those of study conducted in Erzurum[10].

As an average over nitrogen doses the 30 cm row spacing was superior to the 20 and 40 cm. in terms of seed and biological yields (Table 2). On the other hand the 1000 fruit weights were not affected from the row spacings for coriander plant. These results are in agreement with those of Rubió *et al.*[14,15,18], Luayza *et al.*[1] and Kerang[19]. The nitrogen doses differed in their effects on seed yield and showed similar gain in biological yield 1000 fruits weight, although the N_0 application surprisingly produced the highest biological yield in coriander plant. The weight of 1000 fruits is a character of great agronomic importance. The results from this study revealed that 1000 fruits weight ranged from 7.36-9.56 g/1000 fruits (Table 2). Diederichsen[3] indicated that the weight of 1000 fruits vary 2.5 to 20 g/1000 fruits. The results obtained in this study are in range those of given by Diederichsen[3]. He pointed out that a Georgian accession had the smallest fruits, with a weight of 1000 fruits of 4.3 g. In 1994, a year with unfavourable weather conditions, the same accessions had a minimum weight of 2.5 g/1000 fruits. The largest fruits

Table 1: Means for plant heights, umbel number per plant and fruits per umbel on different row spacing

Nitrogen doses	Row spacing (cm) Plant heights (cm)* 20	30	40	Means	Umbel number per plant* 20	30	40	Means	Fruits per umbel (number/umbel)* 20	30	40	Means
N_0	39.00	37.80	39.43	38.74^{a}	4.83	6.05	6.20	5.69^{a}	17.19	18.40	16.29	17.29^{b}
N_1	35.13	39.86	33.20	36.06^{a}	4.03	5.33	5.66	5.01^{a}	21.41	20.68	22.85	21.64^{a}
N_2	35.24	34.83	40.90	36.99^{a}	5.35	5.76	7.33	6.15^{a}	19.23	17.89	18.63	18.58^{b}
N_3	32.16	39.06	34.90	35.37^{a}	3.56	6.76	6.36	5.56^{a}	17.90	18.87	18.14	18.30^{b}
Means	35.38^{b}	37.89^{a}	37.10^{a}		4.44^{a}	5.98^{a}	6.39^{a}		18.93^{a}	18.96^{a}	18.97^{a}	

*Values within a column followed by the same letter(s) do not differ according to Duncan's Multiple, Range test (5% level)

Table 2: Means for 1000 fruit weights, seed yield and biological yield on different row spacing

Nitrogen doses	Row spacing (cm) 1000 Fruit weight (g)* 20	30	40	Means	Seed yield (kg ha^{-1})* 20	30	40	Means	Biological yield (kg ha^{-1}) * 20	30	40	Means
N_0	7.73	8.33	7.96	8.01^{a}	942.50	1133.0	899.40	991.70^{ba}	1678.4	2138.0	1766.8	1859.4^{a}
N_1	7.36	8.43	9.56	8.45^{a}	644.00	803.00	781.20	742.80^{b}	1341.0	1712.8	1447.2	1500.4^{a}
N_2	8.40	8.70	8.63	8.57^{a}	878.60	942.90	675.80	832.50^{ba}	1748.1	1746.6	1287.2	1594.0^{a}
N_3	8.53	8.90	8.90	8.77^{a}	696.30	1289.5	1098.5	1028.2^{a}	1401.8	2392.3	1365.7	1720.0^{a}
Means	8.00^{a}	8.59^{a}	8.76^{a}		790.40^{b}	1042.1^{a}	863.7^{b}		1542.4^{b}	1996.2^{a}	1466.8^{b}	

*Values within a column followed by the same letter(s) do not differ according to Duncan's Multiple, Range Test (5% level)

Table 3: Means for hay yield and harvest index

Nitrogen doses	Row spacing (cm) Hay yield (kg ha^{-1})* 20	30	40	Means	Harvest index* 20	30	40	Means
N_0	735.90	1000.00	867.40	867.80^{a}	55.89	52.85	51.02	53.26^{a}
N_1	696.90	907.50	666.00	757.60^{a}	48.00	46.72	53.32	49.36^{a}
N_2	869.50	803.70	611.40	761.60^{a}	50.86	53.93	52.56	52.45^{a}
N_3	705.50	1102.70	267.10	691.80^{a}	49.38	53.96	117.54	73.63^{a}
Means	752.00^{ba}	954.10^{a}	603.00^{b}		51.04^{a}	51.87^{a}	68.62^{a}	

*Values within a column followed by the same letter do not differ according to Duncan's, Multiple Range Test (5% level)

had a weight of 20 g/1000 fruits and large fruits are more exceptional and 75% of the accessions had a weight of 1000 fruits lower than 12.5 g[3,16,18-23].

Maximizing biological gain, in particular, seed gain is an important consideration in choosing breeding method. Since the four nitrogen doses gave similar biological yield gain and three row spacing and nitrogen doses gave different seed yield gain further analysis gave advantage to make and general conclusion Thus N_3 application followed 30 cm. row spacing produced highest seed and biological yield (the results of multiple comparisons for row spacing-nitrogen dose combination not presented). The results introduces for effects of nitrogen are in agreement with many researchers[11,22].

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