Indian J. Hort. 67(Special Issue), November 2010: 470-473

Short communication

Effect of intra row spacing and nitrogen on growth and physiology of colocynth grown on desert soils

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Colocynth (*Citrullus colocynthis* L.) is a perennial cucurbit grows naturally in the sandy habitat of the arid zones. In India colocynth found abundantly from July to November on sand dunes, sandy undulating plains and interdunal areas in the annual rainfall zones of 150-300 mm. It has good yield potential even under 35-40 mm rainfall and can produce up to 250 quintals of fruits and 10-12 quintals of seed in a hectare (Kumawat *et al*., 6). During good rainfall years the production of fruits can be up to 400-500 quintals. On dry weight basis colocynth fruit contains 50 % seeds which have 26.6 % oil and 13.5 % protein. From nutrition point of view its oil has resemblance with safflower oil and in some African and Middle Eastern countries it is being used for cooking (Akubor, 1). Fresh fruit of colocynth can be employed in preparation of preserve, candy, pickle and other confectionary items after suitable chemical treatment. Besides, oil cake obtained from defatted seeds can be used as feed for dairy animals and in agriculture to supply plant nutrients as well as to control soil borne insect pests (Kumawat *et al*., 5). Profuse spreading behaviour of colocynth vines covers and creeps the loose sandy surfaces of the desert and may serve the purpose in controlling wind erosion. This untapped plant has unsung potential and its cultivation in arid regions serves many purpose viz. continuous supply of seed (as cash crop) to oil industry, raw material (fresh fruit pulp) for confectionaries, a special phytochemical to pharmaceutical and nutraceutical industry, stabilization of shifting sand, and checking the danger of its becoming extinct due to over exploitation. Keeping in view its potential utility and suitability in desert, present study was carried out to study the effect of plant spacing and nitrogen on dry matter accumulation, nitrate reductase activity and chlorophyll synthesis of colocynth.

The experiment was conducted on Typic Torripsamments at Chandan Farm, CAZRI Regional Research Station, Jaisalmer (Rajasthan) (26° 52' N, 70° 55'E and 194.50 m altitude) during *kharif* 2005 and 2006. The experiment was laid out in a split-plot design with four intra–row spacing (50, 75, 100 and 150 cm) and four levels of nitrogen (0, 20, 40 and 60 kg/ha) with three replications. The rows were 2.5 m apart in all the treatments. A universal dose of 40 kg/ha P was applied to all the treatments before sowing through single super phosphate. Nitrogen was applied through urea (46 % N) at the time of sowing (4th August 2005) in the first year and deep placed round the ratoon plants in the second year at the onset of monsoon in July. The nitrate reductase (NR) activity and total chlorophyll content in the uppermost fully expanded leaves was determined following the method of Jaworski (4) and Arnon (2), respectively. Two plants per treatment were taken at each sampling for growth analysis and leaf area was measured using planimeter. Five fruits from each treatment were taken for estimation of size and weight of fruit, seeds/ fruit and to determine weight and proportion of rind, pulp and seed to total fruit weight. Twenty seeds from each treatment were decoated manually for determination of weight and proportion of testa and cotyledon to total seed. The oil content in seeds was determined by Soxhlet using petroleum ether (60-80°C) as solvent. The data were analyzed separately for two years i.e. 2005 and 2006 and then pooled to get average response.

Total chlorophyll and NR activity (Table 1) in fresh colocynth leaves increased significantly with successive increase in plant spacing from 50 to 150 cm as well as nitrogen from 0 to 60 kg/ha at all the stages (50, 75 and 100 DAS). Leaf area/plant also increased significantly with gradual increase in spacing from 50 to 150 cm and N from 0 to 40 kg/ha (Table 1). The significant increase in chlorophyll content, NR activity and leaf area with successive widening might be attributed to availability of more land area per plant resulting into availability of higher N and moisture to individual plant with least competition helping the plant to grow profusely that resulted in rapid initiation of leaves and their expansion thereby giving higher leaf area Singh and Chonkar (8). The significant increase in chlorophyll content and NR activity in fresh leaves with increased N might be associated with better nutritional environment in the root zone as well as in plant system under the influence of N application which is the basis of fundamental constituent

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Table 1. Effect of various spacing and nitrogen levels on total chlorophyll, nitrate reductase (NR) activity, leaf area per plant and dry matter accumulation at different growth stages of colocynth, mean of *kharif* 2005 and 2006 seasons.

Treatments	Total chlorophyll content(mg/g fresh weight of leaf)			NR activity (μmol NO_2/g/h fresh weight of leaf)			Leaf area /plant (cm^2)			Dry matter accumulation (g/plant)										
										50 DAS		75 DAS			100 DAS			Harvest		
	50 DAS	75 DAS	100 DAS	50 DAS	75 DAS	100 DAS	50 DAS	75 DAS	100 DAS	Leaf	Stem	Leaf	Stem	Fruit	Leaf	Stem	Fruit	Leaf	Stem	Fruit
Spacing (cm)																				
S_{50}	2.12	2.25	2.27	110	125	93	3393	7237	7614	37.0	42.0	38.4	53.2	30.0	46.2	68.0	63.9	53.4	101.5	143.0
S_{75}	2.72	2.64	2.66	119	134	121	3973	8221	8567	48.4	55.5	62.9	88.7	46.2	77.3	109.3	102.1	90.6	169.0	241.9
S_{100}	2.31	2.83	2.72	133	150	134	4641	9928	10123	64.6	60.0	70.3	104.1	54.1	93.0	135.1	124.8	105.8	186.4	313.3
S_{150}	2.39	2.99	2.85	149	167	155	5447	13225	13566	75.5	79.0	79.1	110.6	57.6	134.5	173.8	139.5	122.0	202.1	365.6
CD (p=0.05)	0.06	0.09	0.09	27	8	5	252	430	480	3.3	5.0	4.7	4.3	2.1	6.0	6.5	8.4	6.2	6.8	16.0
Nitrogen (kg/ha)																				
N_0	2.11	2.18	2.19	94	106	96	4075	8878	9249	51.5	46	54.8	72.4	32.1	69.5	95.1	90.6	72.7	144.7	166.5
N_{20}	2.22	2.71	2.71	117	131	115	4331	9524	9779	55.5	54.7	58.6	87.0	47.1	81.9	119.0	106.1	89.6	159.9	263.8
N_{40}	2.37	2.85	2.73	129	146	133	4471	9992	10297	59.7	65.8	64.9	96.5	54.7	93.4	133.4	119.5	100.4	172.1	352.1
N_{60}	2.40	2.98	2.87	172	193	158	4579	10216	10545	62.4	69.8	68.8	100.7	54.1	106.2	138.7	114.3	109.0	182.3	281.3
CD (p=0.05)	0.05	0.08	0.10	26	7	4	201	385	375	3.1	5.3	3.6	4.8	2.8	4.8	5.3	8.4	5.6	7.4	17.8

of chlorophyll and activity of NR enzyme and expansion of leaves in green plants (Kumawat *et al.*, 5).

Dry matter accumulation in leaf, stem, fruit as well as plant increased linearly with successive increase in intra row plant spacing from 50 to 150 cm at all the stages of plant growth, with spacing 150 cm having significantly the highest (Table 1). Similarly, increase in dry matter accumulation at all stages of crop growth was also recorded with increasing nitrogen levels. At harvest, dry matter accumulation in stem and leaf increased linearly with the increased nitrogen levels up to 60 kg/ha whereas in fruits it increased only up to 40 kg N/ha. The increased accumulation of dry matter with successive widening was attributed to availability of more soil moisture and plant nutrients that resulted in longer vine length and rapid initiation of leaves and their expansion thereby giving higher leaf area index (LAI), higher chlorophyll synthesis, nitrate reductase activity and photosynthetic rate which ultimately reflected by higher dry matter accumulation in the plant. Analogous results were reported by Singh and Chonkar (8). In the similar manner, plants supplied with 40 kg N/ha showed more vigorous growth because of increased chlorophyll content, higher nitrate reductase activity, leaf area, leaf number, increased leaf nitrogen concentration and increased vine length which in turn enhanced the photosynthetic capacity of the plant and dry matter accumulation in different plant parts (Kumawat *et al.*, 5).

Though weight of seed and rind to total fruit weight increased significantly with increase in plant spacing from 50 to 100 cm (Table 2), the proportion of seed and rind to total fruit weight decreased with successive widening of plant spacing. However the weight and proportion of pulp increased with the increase in intra row plant spacing. The similar trend in the weight and proportion of these fruit parameters were also noticed with the increasing nitrogen levels. The weight and proportion of testa to total seed weight decreased with the widening of plant spacing from 50-150 cm while that of cotyledon to seed weight increased (Table 2). The proportion of testa and cotyledon to total seed weight showed inverse trend with increasing nitrogen levels as was observed with intra row plant spacing. Significantly the highest cotyledon: testa ratio was recorded with 150 cm plant spacing and 0 kg N/ha. In the present study it was observed that fruit size increased gradually with successive widening of spacing because of higher contribution of fleshiness (pulp) and rind in the total fruit weight. The increased proportion of rind and pulp probably reduced proportion of seeds in the large size fruits obtained with wider spacing. In large size fruits the increased size of seed increases the weight of

Table 2: Effect of various spacing and nitrogen levels dry matter accumulation in fruit and seed, yield and yield attributes of colocynth at harvest, mean of *kharif* 2005 and 2006 seasons.

Treatments	Fruit: Weight to total fruit weight (g) Seed	Pulp	Rind	Fruit: Proportion to total fruit weight (%) Seed	Pulp	Rind	Seed: Wt. to total seed wt. (mg) Testa	*Coty	Seed: Proportion to total seed w.t (%) Testa	*Coty	Yield attributes: *Coty: testa ratio	Fruits /plant	Fruit size (cm)	Fruit wt. (g)	100 seed wt. (g)	Seeds /fruit	Oil content (%)	Yield (kg/ha): Dry matter yield	Dry fruit yield	Seed yield	Oil yield
Spacing (cm)																					
S_{50}	12.6	8.4	8.6	43.0	27.6	29.3	17.9	12.0	59.9	40.1	0.68	4.8	7.9	29.6	3.05	438	25.0	1886	905	385	96
S_{75}	13.2	9.4	9.0	42.1	29.1	28.8	17.4	12.1	59.0	41.0	0.70	7.6	8.5	31.5	3.09	516	25.6	2173	1048	438	111
S_{100}	14.2	10.6	9.4	41.8	30.6	27.6	16.7	12.2	57.8	42.2	0.73	9.3	8.8	34.2	3.12	520	25.8	2018	1044	435	112
S_{150}	13.4	12.0	9.5	39.1	33.8	27.1	16.4	13.3	55.2	44.8	0.82	10.4	9.1	34.9	3.12	538	26.0	1494	792	305	79
CD (p=0.05)	0.9	0.6	0.4	NS	1.6	0.9	0.6	0.6	1.6	1.4	0.04	0.7	0.3	1.5	NS	22	0.6	92	59	21	5
Nitrogen (kg/ha)																					
N_0	9.6	5.6	6.2	44.7	26.1	29.3	16.3	13.6	54.4	45.5	0.84	7.8	8.2	21.4	2.98	459	26.7	1388	590	264	71
N_{20}	13.8	9.8	9.1	42.5	29.8	27.8	16.8	12.6	57.2	42.9	0.75	8.0	8.4	32.6	3.02	476	26.0	1864	942	402	105
N_{40}	16.4	12.9	11.6	40.5	31.3	28.2	17.4	12.1	59.0	41.0	0.70	8.4	8.7	40.9	3.27	531	25.1	2251	1256	509	128
N_{60}	13.5	12.1	9.7	38.5	33.9	27.6	18.0	11.4	61.2	38.8	0.64	7.9	8.8	35.3	3.11	546	24.7	2069	1002	387	95
CD (p=0.05)	0.5	0.7	0.5	2.1	1.5	1.2	0.6	0.5	1.5	1.5	0.04	0.5	0.3	1.1	0.15	26	0.3	86	43	20	5

*Coty=Cotyledon

cotyledon thus increased the proportion of the cotyledon to total weight of seed compared to narrow spacing. Similarly increased supply of nitrogen increased the proportion of pulp (fleshiness) in the fruits and thereby reducing the seed and rind proportion. The low level of nitrogen might have increased the competition for N between seed and leaves. Thus deficiency of nitrogen decreased the size of the seed.

The number of fruits per plant at harvest varied within the intra row spacing from 4.8 to 10.4 fruits, with spacing 150 cm having significantly the highest (Table 2). Similarly, average size and weight of fruits increased linearly with successive increase in plant spacing. However, 100–seed weight remained at par among all the spacings. Although oil content among 75, 100 and 150 cm spacing recorded at par with each other, intra row plant spacing at 100 cm recorded 3% higher oil content in the seeds compared to 50 cm spacing (25.0 %). The total dry matter production, dry fruits, seeds and oil yields per hectare increased significantly with the increase in intra row plant spacing only up to 75 cm. The increased yield attributes with increased plant spacing was ascribed to increased crop growth. In the study fruits per plant is positively correlated (r=0.92) with the number of leaves per plant. Thus, fruits per plant decreased in closer spacing owing to reduced leaf area per plant. Analogous results were also observed by Gichimu *et al*. (3) in watermelon. The higher oil content in the seeds with increasing spacing in the study attributed to increased proportion of cotyledon (40 to 45 %) with concomitant decreased proportion of the testa (60 to 55 %). Though per plant dry matter and yield attributes increased linearly with the increase of plant spacing, the dry matter yield, dry fruit, seed and oil yield per unit area was higher under 75 cm planting spacing due to higher population of plants per unit area compared to 100 and 150 cm. From the results it is evident that application of N up to 40 kg/ha recorded significant increase in yield attributes (fruits/plant, fruit weight and 100-seeds weight) as well as dry matter accumulation per hectare of colocynth (Table 2). In the study, fruit size and seeds/fruit increased with increase in N up to 60 kg/ha, the oil content in seeds decreased from 26.7 to 24.7% with the increase in nitrogen levels from 0 to 60 kg/ha. The significant improvement in fruits/plant, average size and weight of fruit with successive increase in N level up to 40 kg/ha in the study might be associated with increased physiological growth of the plant. Further increase in nitrogen level decreased number of fruits per plant due to shift of sex ratio in favour of staminate flowers (Robinson and Decker–Walters, 7). The decreased number of fruits per plant with 60 kg N/ha probably decreased the total dry matter yield per unit area compared to 40 kg N and thereby lower fruit, seed and oil yield.

Thus, it can be concluded that intra-row spacing of 75 cm and 40 kg N/ha is more important than other spacing and N levels for maximum dry matter production, fruit, seed and oil yield per hectare from colocynth.

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Received: March, 2009; Revised: January, 2010
Accepted: August, 2010