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Response of garlic cultivars to irrigation levels

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ABSTRACT

An experiment was conducted during 2012-2013 at College of Horticulture, Mandsaur (M.P.) to study the effect of garlic (*Allium sativum* L.) cultivars to different irrigation levels. The experiment was laid out in split plot design with 20 treatments, comprising of five cultivars, *viz*. G-1 (V_1), G-41 (V_2), G-323 (V_3) G-50 (V_4) and G-282 (V_5) and four irrigation levels, *viz.* 6 irrigation (I_1), 9 irrigation (I_2), 12 irrigation (I_3) and 15 irrigation (I_4). The cultivar G-323 (V_3) along with 15 irrigation (I_4) level was found significantly superior in terms of plant height, number of leaves, chlorophyll content in leaves, neck thickness, weight of 20 cloves, number of cloves per bulb, polar diameter of bulb, equatorial diameter of bulb, fresh bulb weight, dry bulb weight, bulb yield, sulphur content of bulb, gross return, net return and benefit: cost ratio. However, leaf area index and days to maturity was recorded highest in cultivar G-41 (V_2) along with 15 irrigation (I_4) level and volatile oil content of bulb, TSS content and ascorbic acid contents of bulb was recorded highest in cultivar G-282 (V_5) along with 15 irrigation (I_4) level.

Key words: *Allium sativum,* bulb, garlic, irrigation levels, cultivars.

INTRODUCTION

Garlic (*Allium sativum* L.) is an herbaceous annual and the second most important bulb crop after onion. Its pungent flavour makes it used mainly as a spice, seasoning and flavoring for foodstuff involving both green tops and bulbs. Its medicinal value is also well recognized in the control and treatment of hypertension, worms, germs, bacterial and fungal diseases, diabetes, cancer, ulcer, rheumatism etc. (Kilgori *et al*., 8). India ranks second in area and production of garlic in the world. It is cultivated in 242.49 thousand hectares producing 1,228.32 thousand MT with productivity of 5.06 tonnes ha^{-1} (NHB, 9). In India, Madhya Pradesh ranks first in area and second in production after Gujarat. In Madhya Pradesh, it is grown in about 60,000 thousand hectare with total production of 2,70,000 MT giving an average production of 4.5 tonnes ha^{-1} (NHB, 9).

Garlic is grown on a larger area in Malwa plateau of M.P. but its cultivation is affected by several factors. Among the different factors affecting growth, yield and quality of garlic, number of irrigation and selection of cultivar appears to be most important factors for maximizing the growth, highest yield and good quality garlic bulb production. Soil moisture is an important factor that influences the growth, development and yield of garlic. Growing period of garlic is mainly dry and soil moisture is dependent on the irrigation and its frequency. Optimum water application is a pre-requisite to successful garlic production in relation to bulb size, weight and quality. Garlic requires adequate moisture for good establishment, growth, development of bulb, yield and bulb quality Karaye and Yakubu (6).

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MATERIALS AND METHODS

The experiment was carried out at the Research Farm, College of Horticulture, RVSKVV, Mandsaur, Madhya Pradesh during 2012-13. The soil of the experimental field was light black loamy in texture with pH 7.2 and 0.24 dS/m, having low level of available nitrogen (140 kg ha^{-1}), medium in available phosphorus (21.0 kg ha^{-1}) and low in available potassium (144.0 kg ha^{-1}).The experiment was laid out in split plot design. There were 20 treatment combinations with five cultivars, *viz*., G-1 (V_1), G-41 (V_2), G-323 (V_3) G-50 (V_4) and G-282 (V_5) and four irrigation levels, *viz*., 6 irrigation (I_1), 9 irrigation (I_2), 12 irrigation (I_3) and 15 irrigation (I_4), replicated thrice in 60 well ploughed beds of 3.0 m × 1.5 m size with a sowing distance 15 cm × 10 cm. A basal dose of well rotten farmyard manure @ 10 tonnes ha^{-1} was incorporated in the soil before one month of sowing. In addition to this, a uniform dose of 150 Kg N ha^{-1} through urea, 60 kg P_2O_5 ha^{-1} through SSP (single super phosphate), 40 kg K_2O ha^{-1} through MOP (muriate of potash) and 60 kg sulphur ha^{-1} was applied for better growth and proper nutrition of garlic. Nitrogen was applied in two splits. The half amount of nitrogen with full doses of P_2O_5, K_2O and sulphur were applied as basal, at the time of sowing. The remaining nitrogen was top dressed at 30 day after sowing. Cloves of healthy bulbs of 8-10 mm in diameter were dibbled 5-7 cm deep keeping their growing ends

upwards, on 9th November during 2012, After sowing cloves were covered with the thin layer of soil for its proper germination. For the establishment of the garlic crop, first irrigation was given just after sowing then subsequent irrigations were given as per the treatments at the level of 6, 9, 12 and 15 irrigations. Initial three irrigations were applied for each main-plot only for crop establishment. In order to protect the crop sprayed with Mancozeb® @ 2.5 g/l of water for stemphylium blight and purple blotch and Fipronil® 0.2-0.3 ml/l of water for thrips. Harvesting was done manually by hand digger when the top turn yellowish or brown colour and shown signs of drying up and bend over (neck fall stage). Growth observations on (plant height, number of leaves per plant were recorded at 60, 90 and 120 DAS and leaf area index were recorded by using electronic leaf area meter at 90 and 120 DAS) The yield attributes and yield (neck thickness, number of cloves per bulb, weight of 20 cloves, days taken to maturity, polar diameter of bulb, equatorial diameter of bulb, bulb fresh weight, dry bulb weight, bulb yield) were recorded at the time of harvest. Quality attributes such as total soluble solids of bulb was determined with hand refractometer, volatile oil content in bulb was determined by using essential oil distillation assembly AOAC (1), sulphur content in bulb was estimated by turbidometric method Tabatabai and Bremner (17), ascorbic acid content in bulb was analysed by metaphosphoric acid and titrating with 2, 6-dichlorophenol indophenol solution AOAC (1) after harvest the crop. Chlorophyll content in leaves was measured by SPAD meter at 60 and 90 DAS.

RESULTS AND DISCUSSION

Different attributes significantly higher such as plant height, number of leaves per plant at 60, 90 and 120 DAS and chlorophyll content of leaves 60 and 90 DAS, leaf area per plant at 90 and 120 DAS were recorded as a result of higher irrigation level (Table 1). The garlic crop supplied with 15 irrigations resulted in almost significantly higher plant height at 60 (58.2), 90 (75.9) and 120 (84.5) DAS, number of leaves per plant at 60 (6.4), 90 (8.8) and 120 (10.5) DAS, chlorophyll content of leaves at 60 (77.73) and 90 (107.73) DAS and leaf area per plant at 90 (1.48) and 120(1.54) DAS over the other irrigation levels. These significant variations may be attributed to varied moisture status. The vigorous growth in garlic means production of more leaves, which helped in the synthesis of more photosynthates and thus resulting in increased accumulation of carbohydrates and other metabolites, which ultimately determined the size and weight of bulbs. The above findings are in close conformity with the findings of Ahmed *et al*. (2).

The significant improvement in yield attributes and yield of garlic with the 15 irrigation level (Tables 1 & 2) could be ascribed to overall improvement in vigour and crop growth. Since an adequate irrigation level is considered important in promoting rapid vegetative growth, number of leaves per plant, plant height and leaf area per plant. There by increasing the sink size in terms of bulb size. Higher irrigation level stimulated days taken to maturity (143.1), neck thickness (10.05), weight of 20 cloves (34.67), equatorial bulb diameter (4.81), polar bulb diameter (5.06), number of cloves per bulb (29.60), fresh weight of bulb (50.94), dry weight of bulb (17.44) and bulb yield (144.67) significantly. Improvement in overall growth, *i.e.* plant height, number of leaves and leaf area index with irrigation coupled with increased net photosynthesis towards reproduction structure, on the other, might have increased the yield attributes significantly. Conversely, minimum irrigation level in the experimental field as affected the crop growth, neck thickness, bulb diameter, number of cloves per bulb, fresh and dry weight of bulb, fresh and dry weight of bulb adversely, under lower level of irrigation. These findings are in close agreement with Singh *et al*. (15)

The quality parameters (Table 2) increase significantly with increase in irrigation levels. Highest TSS content, volatile oil content, sulphur content and ascorbic acid content of bulb was observed with 15 irrigation level. The positive influence of the maximum irrigation level on TSS, volatile oil, sulphur and ascorbic acid content of bulb appears to be due to higher moisture level in the root zone and may be increasing the mobility of nutrients in the soil and consequently higher minerals uptake by plant and increasing carbohydrates assimilation. Increased accumulation of nutrients especially in vegetative plant parts possibly with improved metabolism led to greater translocation of these nutrients to reproductive organs (bulb) of the crop. Significant increase in quality attributes with higher irrigation level was also reported by Ahmed *et al.* (3). The maximum gross return of (Rs. 3,61,668 ha^{-1}), net return of (Rs. 2,96,997 ha^{-1}) and B: C ratio of (4.60:1) was recorded with the 15 irrigations. Similar results were obtained by Shanu *et al.* (14) in coriander and Naruka and Dhaka (10) in garlic.

The cultivar G-323 was significantly superior to cultivar G-50, G-1, G-282 and G-41 (Table 1) with respect to plant height at 60 (59.5), 90 (78.2) and 120 (84.2) DAS, number of leaves per plant at 60 (6.5), 90 (8.9) and 120 (10.4) DAS and chlorophyll content at 60 (80.08) and 90 (101.85) DAS. The cultivar G-41 was significantly superior with respect to leaf area index at 90 (1.53) and 120 (1.62) DAS. This might be due

Table 1. Effect of irrigation levels on growth, yield and quality attributes on some garlic cultivars.

Treatment	Plant height (cm)			No. of leaves per plant			Chlorophyll content (SPAD)		Leaf area index		Neck thickness (mm)	Weight of 20 cloves (g)	No. of cloves per bulb	Days to maturity	Polar dia. (cm)	Equatorial dia. (cm)
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	90 DAS	120 DAS						
Irrigation																
6	54.2	69.5	3.9	5.9	8.2	9.6	68.69	83.69	1.40	1.46	8.55	25.80	23.59	134.5	3.76	3.82
9	55.8	71.3	76.3	6.2	8.5	10.2	75.28	94.29	1.43	1.49	8.92	29.13	25.07	135.8	4.30	3.88
12	57.2	73.5	82.3	6.3	8.6	10.5	76.29	99.29	1.46	1.52	9.67	32.20	27.99	139.5	4.60	4.66
15	58.2	75.9	84.5	6.4	8.8	10.5	77.73	107.73	1.48	1.54	10.05	34.67	29.60	143.1	5.06	4.81
CD at 5%	1.58	1.59	1.14	0.09	0.31	0.16	1.791	1.801	0.016	0.035	0.801	2.081	0.794	0.561	0.236	0.219
Cultivar																
G-1	57.7	73.2	78.6	6.0	8.1	10.1	72.12	93.87	1.29	1.35	8.80	28.17	24.57	136.3	4.05	4.07
G-41	49.4	63.7	71.9	6.0	8.6	10.1	79.40	101.15	1.53	1.62	9.69	31.00	27.53	142.8	4.21	4.34
G-323	59.5	78.2	84.2	6.5	8.9	10.4	80.08	101.85	1.52	1.56	9.78	32.17	28.42	141.3	5.02	4.44
G-50	59.1	75.2	82.3	6.2	8.5	10.3	71.67	93.42	1.40	1.46	8.99	29.17	25.73	135.8	4.29	4.28
G-282	56.0	72.4	79.3	6.2	8.6	10.2	69.23	90.98	1.48	1.51	9.15	31.75	26.55	134.9	4.56	4.34
CD at 5%	1.62	1.56	1.67	0.13	0.20	0.17	1.324	1.324	0.013	0.026	0.555	1.583	1.008	0.628	0.339	0.144

Table 2. Effect of irrigation levels on yield attributes, yield, quality parameters and economics of different garlic cultivars.

Treatment	Bulb FW (g)	Bulb DW (g)	Bulb yield (q ha^{-1})	TSS content (%)	Volatile oil (%)	Sulphur content (%)	Ascorbic acid (mg/g)	Gross return (Rs. ha^{-1}) Rs. 2500/- q^{-1}	Net return (Rs. ha^{-1})	Benefit : cost ratio
Irrigation										
6 irrigation	32.56	12.56	76.81	38.73	0.512	1.115	0.156	192028	130957	2.16:1
9 irrigation	36.18	13.98	102.60	39.47	0.523	1.307	0.159	256490	194219	3.13:1
12 irrigation	43.39	16.39	137.39	40.60	0.542	1.410	0.162	343470	279999	4.42:1
15 irrigation	50.04	17.44	144.67	41.27	0.552	1.471	0.163	361668	296997	4.60:1
CD at 5%	0.595	0.7244	5.008	0.485	0.0044	0.0269	0.0016	12507.06	12519.36	0.200
Cultivar										
G-1	36.72	10.97	103.65	37.58	0.506	1.226	0.153	259127	195656	3.06:1
G-41	42.51	16.76	119.46	40.00	0.529	1.280	0.148	298646	232675	3.51:1
G-323	46.13	20.38	128.17	41.00	0.545	1.385	0.164	320419	259448	4.23:1
G-50	38.35	12.93	107.81	39.92	0.519	1.367	0.150	269535	205564	3.19:1
G-282	39.01	14.43	117.74	41.58	0.563	1.372	0.186	294344	234373	3.89:1
CD at 5%	0.539	0.535	3.822	0.699	0.0038	0.0181	0.0014	9554.608	9556.504	0.151

to difference in their genotype and better adaptability to soil and climate. Such differential behavior in garlic cultivars has also been reported by Dawar *et al.* (3) in onion. Difference in performance of various garlic cultivars under different irrigation levels have also been reported by Singh *et al*. (15). The variation in plant height, number of leaves and leaf area per plant which are indication of the growth, might be due to varietal behavior in a particular climatic conditions as observed by Sandhu and Korla (14) in onion. Similarly, the variation among the garlic cultivars for different irrigation levels might be due to better availability of moisture during the entire crop growth period, which favoured the growth attributes Sankar *et al.* (13). Similar findings have also been reported by Deshmukh and Kulwal (4), and Singh *et al*. (16) in garlic crop.

The cultivar G-323 was significantly superior to cultivar G-50, G-1, G-282 and G-41 with respect to yield and yield attributes (Tables 1 & 2) namely neck thickness (9.78 cm), equatorial bulb diameter (4.44 cm), polar bulb diameter (5.02 cm), fresh bulb weight (46.13 cm), dry bulb weight (20.38 cm), number of cloves per bulb (28.42 cm), fresh weight of 20 cloves (32.17 g) and bulb yield per hectare (128.17 t) were higher in cultivar G-323 as compared to cultivar G-282, G-50, G-41, and G-1, which might be due to the greater genetic potential of the cultivar G-323. Maximum days were taken to maturity (142.8) with cultivar G-41. The higher value for growth parameters recorded in cultivar G-323 is might be these parameters contribute directly or indirectly due to the fact that towards yield and yield attributing characters. These results are in close conformity with the findings of Ghanbari *et al.* (5).

The cultivar G-282 was significantly superior to other cultivars in respect to quality attributes (Table 2). The TSS content of bulb (41.58), volatile oil content of bulb (0.563 g) and ascorbic acid content in bulb (0.168 g) was higher under the cultivar G-282 as compared to the cultivars G-323, G-41, G-50 and G-1. The sulphur content of bulb (1.385 g) was higher under the cultivar G-323 as compared to the cvs G-41, G-50 and G-282 might be due to the difference in their genotypic potential with respect to polygenic traits and adaptability to soil and climate. These findings corroborate the findings of Naruka and Dhaka (10), Naruka and Singh (11) and Singh *et al*. (16). The maximum gross return return of Rs. 3,20,419 ha^{-1}, net return of Rs. 2,59,448 ha^{-1} and benefit: cost ratio of (4.23:1) was recorded with cv. G-323. Similar results were conducted by Shanu *et al.* (14) in coriander and Naruka and Dhaka (12) in garlic.

The interaction effect of irrigation levels and cultivars was found significant for number of leaves at 120 DAS, number of cloves per bulb, polar diameter of bulb, fresh weight of bulb, dry weight of bulb, bulb yield, and quality attributes like sulphur content of bulb and chlorophyll content in leaves at 60 and 90 DAS. Maximum number of leaves per plant at 120 (10.93) DAS, number of cloves per bulb (31.93), polar diameter of bulb (5.46), fresh bulb weight (55.90 g), dry bulb weight (22.90 g), bulb yield (158.43 g), sulphur content of bulb (1.52 g) and chlorophyll content in leaves at 60 (86.00 mg/g) and 90 (116.00 mg/g) DAS were observed with treatment combination cultivar G-323 with 15 irrigations. Maximum days to maturity (145.00) and leaf area index at 90 (1.57) and 120 (1.72) DAS were observed with treatment combination cultivar G-41 with 15 irrigations and volatile oil content (0.58%) was observed with treatment combination cultivar G-282 with 12 and 15 irrigation levels. Although, Irrigation levels and cultivars independently brought significant increase in yield attributes but interaction of both showed that response of irrigation was governed by cultivar and *vice-versa* exhibiting their interdependence for obtaining higher value of these parameters. Thus, it is clear that 15 irrigations in combination with G-323, G-41 and G-282 cultivars showed the positive response regarding the yield and yield attributing characters as obtained in the present study. Different irrigation level provided the variable moisture status to the crop thus affecting the yield significantly. Similarly, the variation among the cultivars for different irrigation is due to the fact that these are adapted differentially to varied moisture status. Similar findings have also been reported by Khan *et al.* (7) in onion crop. The interaction effect of irrigation levels and cultivars was found significant for gross and net return. Maximum gross and net return resulted when cultivar G-323 supplied with the 15 irrigations. Similar results were reported by Shanu *et al.* (14) in coriander and Naruka and Dhaka (1) in garlic.

REFERENCES

1. A.O.A.C. 1970. *Official and Tentative Methods of Analysis*, Washington, D.C. (10^{th} Edn).

2. Ahmed, M.E.M., Derbala, A. and Kader, N.A. 2009. Effect of irrigation frequency and potassium source on the productivity, quality and storability of garlic. *Misr J. Agric. Engg.* **26**: 1245-62.

3. Dawar, N.M., Wazir, F.K., Dawar, M.D. and Dawar, S.H. 2007. Effect of planting density on growth and yield of onion varieties under climatic conditions of Peshawar. *Sarhad J. Agric.* **23**: 911-18.

Table 3. Combined effect of irrigation levels and cultivars on growth, yield and quality parameters and economics.

Treatment	No. of leaves/ plant 120 DAS	Leaf area index		No. of cloves per bulb	Days to maturity	Polar dia. of bulb (cm)	Bulb FW (g)	Bulb DW (g)	Bulb yield (q/ha)	Chlorophyll content (SPAD value)		Volatile oil (%)	Sulphur (%)	Gross return (Rs./ ha)	Net return (Rs./ ha)
		90 DAS	120 DAS							60 DAS	90 DAS				
I1V1	9.83	1.26	1.32	21.20	133.67	3.45	28.83	8.83	61.84	61.53	76.53	0.50	1.01	1,54,608	92,937
I1V2	9.37	1.45	1.56	22.93	140.00	3.70	33.97	13.97	74.30	81.20	96.20	0.50	1.11	1,85,758	1,21,587
I1V3	9.30	1.49	1.48	25.27	138.33	4.12	37.60	17.60	93.44	73.00	88.00	0.53	1.15	2,33,608	1,74,437
I1V4	9.87	1.34	1.44	24.53	130.00	3.60	30.20	10.20	69.91	63.87	78.87	0.50	1.16	1,74,775	1,12,604
I1V5	9.43	1.45	1.49	24.00	130.67	3.92	32.20	12.20	84.56	63.87	78.87	0.54	1.15	2,11,392	1,53,221
I2V1	10.07	1.27	1.34	22.20	133.67	3.79	32.50	9.50	90.63	73.07	92.07	0.50	1.17	2,26,575	1,63,704
I2V2	10.07	1.54	1.58	25.27	142.00	4.18	38.17	15.17	112.59	78.67	97.67	0.52	1.24	2,81,475	2,16,104
I2V3	10.37	1.49	1.57	27.60	140.67	5.05	43.43	20.43	111.55	80.13	99.20	0.53	1.37	2,78,883	2,18,512
I2V4	10.40	1.40	1.46	24.47	131.67	4.05	34.00	11.00	93.22	73.80	92.80	0.51	1.37	2,33,050	1,69,679
I2V5	10.27	1.46	1.50	25.80	131.00	4.42	32.80	13.80	104.99	70.73	89.73	0.55	1.38	262,467	2,03,096
I3V1	10.17	1.29	1.37	26.53	138.33	4.27	39.53	12.53	127.28	74.07	97.07	0.50	1.32	3,18,192	2,54,121
I3V2	10.47	1.56	1.64	30.80	144.33	4.20	44.97	17.97	143.05	79.67	102.67	0.54	1.35	3,57,625	2,91,054
I3V3	10.83	1.52	1.59	28.87	142.00	5.44	47.60	20.60	149.24	81.20	104.20	0.55	1.50	3,73,108	3,11,537
I3V4	10.57	1.43	1.48	26.07	138.67	4.41	42.20	15.20	129.85	74.80	97.80	0.53	1.44	3,24,633	2,60,062
I3V5	10.30	1.50	1.52	27.67	134.00	4.68	42.67	15.67	137.52	71.73	94.73	0.58	1.45	3,43,792	2,83,221
I4V1	10.27	1.32	1.36	28.33	139.33	4.72	46.00	13.00	134.85	79.80	109.80	0.52	1.41	3,37,133	2,71,862
I4V2	10.60	1.57	1.72	31.13	145.00	4.78	52.93	19.93	147.89	78.07	108.07	0.56	1.42	3,69,725	3,01,954
I4V3	10.93	1.55	1.60	31.93	144.00	5.46	55.90	22.90	158.43	86.00	116.00	0.57	1.52	3,96,075	3,33,304
I4V4	10.20	1.44	1.48	27.87	143.00	5.10	47.00	15.33	138.27	74.20	104.20	0.53	1.50	3,45,683	2,79,912
I4V5	10.67	1.51	1.52	28.73	144.00	5.22	48.37	16.03	143.89	70.60	100.60	0.58	1.51	3,59,725	2,97,954
I at V															
CD 5%	0.323	0.023	0.045	1.746	1.089	0.236	0.933	0.927	6.621	2.294	2.293	0.010	0.031	16,549.1	16,552.3
V at I															
CD 5%	0.311	0.025	0.052	1.641	1.060		0.979	1.068	7.505	2.643	2.650	0.012	0.038	18,751.8	18,762.9

4. Deshmukh, S.D. and Kulwal, L.V. 1992. Effect of low temperature storage treatment and planting dates on growth and yield of some varieties of garlic. *Punjab Rao Deshmukh Krishi Vidyapeeth Res. J.* **16**: 100-2.

5. Ghanbari, M., Ganjali, H. and Nori, H. 2012. Comparing irrigation methods and weed control on yield of garlic (*Allium sativum* L.) cultivars. *Int. Conf. Agric. Chem. Env. Sci.* **6-7**: 147-51.

6. Karaye, A.K. and Yakubu, A.I. 2007. Checklist of weeds in irrigated garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) in Sokoto river valley. *J. Weed Sci.* **20**: 53-60.

7. Khan, M.U.H., Imran, M. and Chattha, T. 2005. Effect of irrigation intervals on growth and yield of onion varieties Swat–1 and Phulkara. *J. Appl. Sci. Res.* **1**: 112-16.

8. Kilgori, M.J., Magaji, M.D. and Yakubu, A.I. 2007. Effect of plant spacing and date of planting on yield of two garlic (*Allium sativum* L.) cultivars in Sokoto, Nigeria. *American-Eurasian J. Agric. Env. Sci.* **2**: 153-57.

9. N.H.B. 2012-13. *First Advance Estimates*. National Horticulture Board, Govt. of India, Gurgaon, India.

10. Naruka, I.S. and Dhaka, R.S. 2001. Effect of row spacing and nitrogen fertilization on growth, yield and composition of bulb in garlic (*Allium sativum* L.) cultivars. *J. Spices Arom. Crops*, **10**: 111-17.

11. Naruka, I.S. and Dhaka, R.S. 2001. Interactive effect of nitrogen and cultivars on the growth, yield and quality of garlic (*Allium sativum* L.). *Haryana Agric. Univ. J. Res.* **31**: 38-39.

12. Naruka, I.S. and Singh, B. 2002. Interactive effects of row spacing and cultivars on the yield and yield attributes of garlic (*Allium sativum* L.). *Haryana J. Hort. Sci.* **31**: 262-64.

13. Sankar, V., Lawande, K.E. and Tripathi, P.C. 2008. Effect of microirrigation practices on growth and yield of garlic (*Allium sativum* L.) var. 41. *J. Spices Arom. Crops,* **17**: 230-34.

14. Shanu, Naruka, I.S., Singh, P.P., Shaktawat, R.P.S. and Verma, K.S. 2013. Effect of seed treatment and folior spray of thiourea on growth, yield and quality of coriander (*Coriandrum sativum* L.). *Int. J. Seed Spices*, **3**: 20-25.

15. Singh, G.R.K., Shukla, I.N., Singh, J.P. and Kumar, S. 2007. Studies on effect on varying plant density, planting and irrigation time on growth and yield of garlic (*Allium sativum* L.). *Progr. Agric.* **7**: 167-68.

16. Singh, P., Naruka, I.S., Rathore, S.S., Shaktawat, R.P.S. and Singh, P.P. 2010. Response of garlic (*Allium sativum* L.) cultivars to different date of sowing in Malwa region of Madhya Pradesh. *Indian J. Agric. Sci.* **80**: 639-42.

17. Tabatabai, M.A. and Bremner, J.M. 1970. A simple turbidometric method of determining total sulphur in plant material. *Agron. J.* **62**: 805-6.

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