EFFECT OF IRRIGATION AND FERTILITY LEVELS ON QUALITY PARAMETERS OF GUM GUAR [(*Cyamopsis tetragonoloba* (L.) TAUB.) IN SANDY LOAM SOILS

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ABSTRACT

A field experiment was conducted on sandy loam soils at the Krishi Vigyan Kendra, Junagadh Agricultural University, Nanakandhasar, Gujarat during the summer 2013 and 2014. The sixteen treatment combinations consisted of four levels of irrigation viz., 50 mm depth of irrigation based on IW:CPE ratios of 0.4 (I_1), 0.6 (I_2), 0.8 (I_3) and 1.0 (I_4) as a main plot treatment and four levels of fertility viz., 00:00 N:P_2O_5 kg/ha (F_1), 10:20 N:P_2O_5 kg/ha (F_2), 20:40 N:P_2O_5 kg/ha (F_3) and 30:60 N:P_2O_5 kg/ha (F_4) as sub plot treatment were evaluated using split plot design replicated three times. The whole quantity of N-P_2O_5 was applied as basal through of urea and diammonium phosphate in all the plots as per the treatments. Significantly higher protein content (24.32%), protein yield (325.44 kg/ha), gum content (29.27%) and gum yield (390.94 kg/ha) were recorded under 0.8 IW:CPE ratio over IW:CPE ratios of 0.4 and 0.6, however it remained at par with1.0 IW:CPE ratio. Application of 20-40 N-P_2O_5 kg/ha significantly increased in protein content (24.27 %), protein yield (321.64 kg/ha), gum content (28.84%) and gum yield (382.75 kg/ha) over control.

KEY WORDS: Gum guar, IW/CPE ratio, nitrogen, phosphorus, protein, gum yield

INTRODUCTION

Gum guar [(*Cyamopsis tetragonoloba* (L.) Taub.) is a widely grown crop, but not on commercial basis on large scale at farmer's field. In the recent years, this crop has assumed great significance due to the presence of a good quality of gum in the endosperm of its seed. Due to diversified uses of clusterbean gum in textile, paper, explosive and mining industries, pharmaceuticals, cosmetic goods and food stuffs, it has ever increasing demand in the international market. It is principally used as a feed for livestock and poultry. India is the largest producer of gum guar seed in the world, constitute about 80 per cent of the total production (DES, 2013).

Water need of gum guar may vary with the climatic conditions and type of soil. Hence, scheduling of irrigation at an appropriate time and in right amount is one of the most important factors for realizing high yield of summer gum guar, especially under scarce and costly irrigation water. Scheduling of irrigation based on climatological approach may provide information not only about

water use of the crop, but also about the proper time of irrigation as suggested by Parihar *et al*. (1974). Among different nutrients, nitrogen is one of the most expensive and important nutrients. Phosphorus content of soils is either low or medium. This is alarming because P is the backbone of balanced fertilizer use and it occupies a key place in intensive agriculture. Phosphorus also showed significant influence on yield, protein, gum content and uptake of P in clusterbean (Bhadoria *et al*., 1997).

MATERIALS AND METHODS

A field experiment was conducted during the summer 2013 and 2014 at the Krishi Vigyan Kendra, Junagadh Agricultural University, Nanakandhasar, Dist: Surendranagar, Gujarat to study the response of gum guar to irrigation and fertility levels in summer season. The soil of the experimental plot was sandy loam in texture and slightly alkaline in reaction with pH 7.90 and EC 0.33 dS/m. The soil was low in available nitrogen (197.5 kg/ha), medium in available phosphorus (43.8 kg/ha) and high in available potash (286.5 kg/ha). Gujarat Guar 2 variety was selected for the present investigation, as it is more popular in this region. The sixteen treatment combinations consisted of four levels of irrigation *viz*., 50 mm depth of irrigation based on IW: CPE ratios of 0.4 (I_1), 0.6 (I_2), 0.8 (I_3) and 1.0 (I_4) as a main plot treatment and four levels of fertility *viz*., 00:00 N:P_2O_5 kg/ha (F_1), 10:20 N:P_2O_5 kg/ha (F_2), 20:40 N:P_2O_5 kg/ha (F_3) and 30:60 N:P_2O_5 kg/ha (F_4) as sub plot treatment were evaluated using split plot design with three replications. The quantity of fertilizer was drilled in the soils at 5 cm below the seed according to fertilizer treatments as a basal dose. The seeds were sown keeping 45 cm row spacing using 20 kg seeds / ha on February 19 and 20 during 2013 and 2014, respectively. Irrigation water was measured with a 7.5 cm parshall flume having a throat size of 7.5 cm installed in field channel in the experimental field. Irrigation water of 50 mm depth was applied at each irrigation. In order to evaluate the effect of treatments on protein content (%) in seed was calculated by multiplying the nitrogen content (%) in seed by the factor 6.25 as reported by Angelo and Mann (1973). Protein yield ha^{-1} was calculated by following formula.

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein content (\%) x seed yield (kg/ha)}}{100}$$

For estimation of gum content, the procedure given by Das *et al.* (1977) was used. Thirty gram of guar seeds was taken and subjected to wet processing (2% NaOH) with vigorous boiling at 98ºC for 5 minutes. The solution was sieved through coarse sieve to remove excess NaOH. The leachate was discarded and wet de husked seeds were then air dried for 2-3 days. Later, the dried de husked seeds were pulverized to get endosperm splits and germ meal. Further, the germ meal was discarded using 1mm sieve. Endosperm splits were soaked in distilled water in 1:5 proportions and kept for 4-5 hours. The soaked splits were then ground in a blender to get viscous solution of thick consistency and it was kept overnight. Later, the thick solution was disturbed using glass rod and then 50-100 ml of isopropanol was added leading to precipitation of gum on the top. Further, excess isopropanol was removed from the lumps (gum) with the help of strainer and the lumps were then vacuum dried. Dried lumps were further powdered in a blender and the gum content was calculated. Gum yield/ha was worked out by using the following formula

$$\text{Gum yield (kg/ha)} = \frac{\text{Gum content (\%) x seed yield (kg/ha)}}{100}$$

RESULTS AND DISCUSSION

Effect of irrigation levels on protein content and protein yield

Data presented in Table 1 showed that different irrigation treatment had significant influence on protein content in seed of gum guar. Application of irrigation at 1.0 IW:CPE ratio recorded significantly higher protein content (24.78, 24.52 and 24.65%) than 0.4 and 0.6 IW:CPE ratios in 2013, 2014 and pooled results, respectively and remained at par with 0.8 IW:CPE ratio. Irrigating the gum guar at an IW:CPE ratio of 1.0 produced significantly higher protein yield (349.53, 315.39 and 332.46 kg/ha) than IW:CPE ratios of 0.4 and 0.6 in 2013, 2014 and combined results, respectively. Irrigation levels 1.0 and 0.8 IW:CPE ratios, on an average, increased protein content by 11.19 and 9.70 per cent and protein yield by 42.50 and 39.49 per cent, respectively over 0.4 IW:CPE ratio in pooled results (Table 1). This might be due to the fact that better moisture condition prevailed in the soil at growth and development stages may increase the availability of nitrogen and finally the nitrogen content, resulting in to higher protein content in the seeds. A marked increase in seed yield and protein content as well with I_3 and I_4 over I_1 were directly responsible for higher protein yield. These findings are in harmony with those of Soni and Gupta (1999) in greengram and Raddy and Babu (2000) and Patel *et al.* (2011) in clusterbean.

Effect of fertility levels on protein content and protein yield

Application of fertilizer at 30-60 N-P_2O_5 kg/ha recorded significantly the highest protein content (24.86, 24.66 and 24.76%) in 2013, 2014 and pooled results, respectively, but did not differ statistically from that of 20-40 N-P_2O_5 kg/ha (Table 1). Fertilizer levels could compel their significant influence on protein yield in individual years and pooled results. Application of fertilizer at 30-60 N-P_2O_5 kg/ha recorded significantly the highest protein yield (338.55, 321.54 and 330.04 kg/ha) in 2013, 2014 and pooled results, respectively and remained statistically at par with 20-40 N-P_2O_5 kg/ha. Fertility levels 30-60 N-P_2O_5 kg/ha and 20-40 N-P_2O_5 kg/ha, on an average, increased protein content by 13.89 and 11.63 per cent and protein yield by 46.03 and 42.31 per cent, respectively over 00-00 N-P_2O_5 kg/ha on pooled basis (Table 1). This could be due to the higher fertility level increases the cation exchange capacity of plant roots and make them more efficient to absorb the nutrients. Another reason for higher nitrogen content might be due to increased activity of nitrate reductase enzyme. This could also be explained on the basis of better availability of desired and required nutrients in crop root zone and enhanced photosynthetic and metabolic activity resulting in better partioning of photosynthates to sinks, which reflected in quality enhancement in terms of ascorbic acid and protein content. The higher protein at higher nitrogen levels was mainly due to structural role of nitrogen in building up amino acids. Phosphorus being an energy source also plays an important role in protein synthesis. A distinct increased in seed yield as well as protein content with higher fertility levels over F_1 was directly accountable for higher protein yield. These results are in close conformity with the findings of Ayub *et al.* (2011) and Bahadur and Chaplot (2014).

Effect of irrigation levels on gum content and gum yield

Different irrigation treatment had significant influence on gum content in seed of gum guar. Application of irrigation at 1.0 IW:CPE ratio recorded significantly higher gum content (30.58, 30.70 and 30.64%) in 2013, 2014 and pooled results, respectively and remained at par with 0.8 IW:CPE ratio during individual years of experimentation (Table 2). The gum yield differed significantly due to irrigation treatments in both the years as well as in pooled results. Application of irrigation at 1.0 IW:CPE ratio recorded significantly higher gum yield (430.24, 394.48 and 412.36 kg/ha) over the 0.4 and 0.6 IW:CPE ratios in 2013, 2014 and pooled results, respectively, which remained statistically at par with 0.8 IW:CPE ratio. Irrigation levels 1.0 and 0.8 IW:CPE ratios, on an average, increased gum content by 15.54 and 10.37 per cent and gum yield by 48.17 and 40.47 per cent, respectively over 0.4 IW:CPE ratio in pooled results (Table 2). The lower value of gum content was recorded in treatment 0.4 IW:CPE ratio, it was mainly due to the fact that moisture stress created due to reduction in irrigation frequency may leads to decrease in the activity of glutamine and glutamate synthesis and increase in the proline content, which ultimately reduce the gum synthesis in guar seeds. The significant increased in seed yield and gum content as well with I_3 and I_4 over I_1 were directly responsible for higher gum yield. These finding are akin to those of EI-Ghawwas *et al*. (1996) and Patel *et al.* (2011).

Effect of fertility levels on gum content and gum yield

Different fertility levels could compel their significant influence on gum content of gum guar in both the years of experimentation as well as in pooled results. Application of 30-60 N-P_2O_5 kg/ha recorded significantly higher gum content (29.79, 29.89 and 29.84%) during 2013, 2014 and in pooled results, respectively (Table 2). Various levels of fertilizer significantly influenced the gum yield in individual years and pooled results. Fertility level 30-60 N-P_2O_5 kg/ha recorded significantly the highest gum yield of 405.65, 390.17 and 397.91 kg/ha in 2013, 2014 and pooled results, respectively, which was statistically at par with corresponding gum yield of 389.68, 375.82 and 382.75 kg/ha recorded by 20-40 N-P_2O_5 kg/ha. Fertility levels 30-60 N-P_2O_5 kg/ha and 20-40 N-P_2O_5 kg/ha, on an average, increased gum content by 7.61 and 4.00 per cent and gum yield by 37.71 and 32.47 per cent, respectively over control (Table 2). Gum content was increased due to fat and carbohydrate synthesis in seeds by the increasing levels of phosphorus which enhanced the biosynthesis of phospholipids and nucleic acids. A remarkable increased in seed yield and gum content with higher fertility levels over control was directly responsible for higher gum yield. These finding are akin to those of Baboo and Rana (1995), Meena *et al.* (2006), Bahadur and Chaplot (2014).

Interaction effect

Interaction effect of irrigation and fertility levels with respect to protein content, protein yield, gum content and gum yield was non-significant during individual years of experiment as well as in pooled results (Table 1 & 2).

CONCLUSION

On the basis of above results and discussion, it was observed that significantly higher protein content (24.32%), protein yield (325.44 kg/ha), gum content (29.27%) and gum yield

(390.94 kg/ha) were recorded under 0.8 IW:CPE ratio over IW:CPE ratios of 0.4 and 0.6, however it remained at par with 1.0 IW:CPE ratio. Application of 20-40 N-P_2O_5 kg/ha significantly increased in protein content (24.27 %), protein yield (321.64 kg/ha), gum content (28.84%) and gum yield (382.75 kg/ha) over control.

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Table 1: Effect of irrigation and fertility levels on protein content and protein yield in gum guar.

Treatments	Protein Content (%)			Protein Yield (kg/ha)		
	2013	2014	Pooled	2013	2014	Pooled
Irrigation Levels (IW:CPE ratio)						
I_1: 0.4	22.18	22.16	22.17	235.93	230.66	233.30
I_2: 0.6	23.40	22.83	23.11	281.72	265.19	273.45
I_3: 0.8	24.52	24.11	24.32	343.60	307.27	325.44
I_4: 1.0	24.78	24.52	24.65	349.53	315.39	332.46
S.Em. ±	0.31	0.43	0.27	9.68	5.28	5.51
C.D. at 5%	1.08	1.49	0.82	33.51	18.27	16.99
C.V. %	4.54	6.39	5.53	11.08	6.54	9.28
Fertility Levels (N-P_2O_5 kg/ha)						
F_1: 00-00	21.94	21.54	21.74	240.64	211.37	226.01
F_2: 10-20	23.72	23.23	23.48	302.03	271.89	286.96
F_3: 20-40	24.36	24.18	24.27	329.57	313.71	321.64
F_4: 30-60	24.86	24.66	24.76	338.55	321.54	330.04
S.Em. ±	0.27	0.34	0.22	7.61	6.18	4.90
C.D. at 5%	0.78	0.99	0.62	22.21	18.03	13.95
C.V. %	3.92	5.02	4.49	8.71	7.65	8.24
Interaction	NS	NS	NS	NS	NS	NS

Table 2 : Effect of irrigation and fertility levels on gum content and gum yield in guar.

Treatments	Gum content (%)			Gum yield (kg/ha)		
	2013	2014	Pooled	2013	2014	Pooled
Irrigation Levels (IW:CPE ratio)						
I_1: 0.4	26.64	26.41	26.52	282.60	274.03	278.31
I_2: 0.6	28.08	28.29	28.18	337.53	328.50	333.01
I_3: 0.8	29.24	29.30	29.27	408.77	373.11	390.94
I_4: 1.0	30.58	30.70	30.64	430.24	394.48	412.36
S.Em. ±	0.44	0.49	0.33	12.01	12.33	8.61
C.D. at 5%	1.51	1.69	1.01	41.57	42.67	26.52
C.V. %	5.29	5.89	5.60	11.41	12.47	11.92
Fertility Levels (N-P_2O_5 kg/ha)						
F_1: 00-00	27.79	27.67	27.73	304.97	272.91	288.94
F_2: 10-20	28.14	28.27	28.20	358.84	331.21	345.03
F_3: 20-40	28.81	28.88	28.84	389.68	375.82	382.75
F_4: 30-60	29.79	29.89	29.84	405.65	390.17	397.91
S.Em. ±	0.19	0.23	0.15	8.41	8.43	5.95
C.D. at 5%	0.57	0.68	0.43	24.54	24.61	16.94
C.V. %	2.35	2.80	2.58	7.98	8.53	8.25
Interaction	NS	NS	NS	NS	NS	NS

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