Original Research Article

Phenotypic Traits Analysis of *Cucumber* Germplasm in Qatar and Indian Agro-climatic Zone

ABSTRACT

This study included four genotypes of cucumber (IC257296, IC420405, GYNE-5, PUSA SANYOG) which were evaluated to find out their similarities and differences based on phenotypic traits when grown under two different soil zones of Doha (Qatar) and Meerut (India). The experiments were laid out in Randomized Complete Block Design (RBCD) with two replicates. The crop was seeded directly after the soil was well prepared using standard agronomical practices. Fertilizers, irrigation and pest management were done on proper time and in standard manner. Half dose of fertilizer was applied at the time of sowing and half after 28 days. Randomly five plants from each row were selected for data analysis. Statistical analysis for variation in quantitative characteristics among genotypes were done using data with respect to germination %age, days to 50% flowering, days to fruit initiation, days to edible maturity, vine length, fruits per plant, fruits per kilogram, fruit length, fruit width and yield. Data showed great variations for almost all the traits. In Indian soil zone, maximum germination (67.5%) was observed in genotype GYNE-5 while minimum germination (17.5%) was recorded in genotype IC257296. The genotypes IC420405, PUSA SANYOG showed early flowering. Similarly, in Qatar soil zone, highest yield was observed in PUSA SANYOG. Correlation analysis represent that yield was positively correlated with fruit length (.523** P≤0.01) and fruit width (.439* P≤0.01) while fruit per plant showed positive significant correlation with vine length. Present findings suggest PUSA SANYOG to be applicable in cucumber cultivation in other areas with similar climatic conditions. This will help to improve the protected agriculture model of Qatar and revenue generation for the farmers.

Keywords— Cucumber, Phenotypic, Traits, Genotype and yield, Qatar soil, Indian soil

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INTRODUCTION

The native place for cultivation of cucumber is Himalaya to China (Yunnan, Guizhou, Guangxi) and North Thailand where it is known to be cultivated since last 3000 years. It is an annual plant that grows primarily in the seasonally dry tropical biome (Royal Botanic Gardens, Kew, 1753). Annual world production of cucumber (*Cucumis sativus* L.) is estimated to 91,258,272 Metric tonnes (FAO, 2021). China is the largest producing country of cucumber. In India and Qatar, it is one of most preferred green vegetable used as "salad". Cucumber is the second most widely cultivated member of the family Cucurbitaceae in the world after watermelon (FAO, 2006). It is grown primarily for processing (pickling) or for fresh market (slicing). The cucumber fruit is known to have cooling effect which prevents constipation and indigestion, also keeps jaundice under control (Nandkarni, 1927). Cucumber is a low calorie (15 calories/100 g only) vegetable, contains 95% water, ideal hydrating and cooling food, excellent source of some unique anti-oxidants, rich in potassium and vitamin K (Pandey et al., 2020); also rich in vitamin 'B' and 'C' as well as minerals such as calcium, phosphorus, iron and potassium. Besides these, it contains about 2.5% carbohydrate (13 Kcal energy), 0.4% protein, 0.1% fat and 0.4% fibre (Gopalan et.al., 1982). It has antioxidants which help to discard substances from the body known as free radicals, however, if accumulated more in the body, they can lead to cell damage and various types of disease (Wang et.al., 2007; Pandey et al., 2020).

Cucumber requires a warm climate, with optimum day and night temperature in the range 20-30 ℃, however, parthenogenetic varieties can be grown round the year in Naturally Ventilated Polyhouse (NVP).It is grown throughout the year in southern states of India, however, in plains of Northern India, it is grown during summer and rainy seasons in open fields. Modern farmers are growing cucumber in winter also under protected cultivation. In Qatar, cucumber is widely grown in greenhouses resulting in 82.7% of the total production of 2952 metric tonnes FAO, 2021). In 2007, more than 13,000 tons of cucumber was consumed, while the local production was only >8,500 tonnes and thus resulting in deficit of 35% (DAWR, 2007). The deficit of cucumber is high in summer and early autumn months, while, consumption rate is 70-90% during winter and spring months (Moustafa, 2010). India has emerged as one of the largest exporter of cucumber (gherkins) in the world (1,23,846 Metric Tonnes with a value of USD 114 million during April-October,2020-21-Ministry of Commerce and Industry23rd January, 2022).

Cucumber production has the capacity to enhance agricultural production, economic empowerment of the farmers and add to nutritive value of the food consumed. In spite of being native of India and one of the major grown crops in Qatar, yield is very low due to various abiotic and biotic stresses and lack of appropriate agricultural practices (Miano et al., 1991). Cucumber is very under-marked agriculture crop in terms of its economic potential and therefore, has hardly been explored for breeding programme. Cucumber production can be potentially increased by introducing it to more cultivable area, using high yielding genotypes and protected agriculture approach (Al-Rawahi et al., 2011). The objectives of cucumber improvement is to produce high yielding genotypes which have phenotypic traits such as early fruiting, uniform size, cylindrical fruit, soft seeds at edible maturity, free from bitterness, green color with smooth surface and resistant to various (biotic and abiotic) stresses. The ultimate goal of any plant breeding programme is to evolve improved genotypes which are better than the existing ones.

Characterization of different high yielding genotypes of cucumber is of much importance for present and future genetic development program of the crop. Till date, very few public sector varieties are accepted by farmers for commercial cultivation. So, in order to isolate desirable genotypes with higher yield and better quality, there is an urgent need to assess the existing variability under specific environment (Sharma, 1988). Since, morphological representation is the chief step in explanation and understanding of genetic means in cucumber (Staub et. al., 2005), present study is designed as an attempt to characterize cucumber germplasm at morphological basis in different agro-climatic zones and soil conditions of India and Qatar to analyze the genetic pattern of morphological character of cucumber. The main objective is to identify the high yielding variety of Cucumber in Qatar agro-climatic zone and to quantify yield potential of cucumber germplasm for future utilization.

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MATERIALS AND METHODS

Cucumber grows well in warm climate, a well drained soil, sandy loam to sandy clay loam with optimum day and night temperature in the range of 20 to 30℃, soil temperature, fertility and moisture content must be adequate. It does not need special care and is widely cultivated throughout the world including India and Qatar.

1. **Experimental Site and Field operations**

The experiments were carried out in the Agricultural Research Farm of Shobhit Institute of Engineering & Technology, Meerut, India and is characterized by monsoon influenced humid subtropical climate with hot summers and cooler winters. Summers are extremely hot and duration is from April-June. The monsoon season starts from late June and ends in middle of September. During monsoon, humidity remains high with cloud cover and low temperature (www.meerut.nic.in, 2022). Winter season is dry and mild from November to the middle of March. In Qatar, experiments were done in Al Thumama, Doha which is characterized by an arid and semi-arid climate. Rainfall is highly unpredictable in space and time with annual precipitation generally less than 50 mm. Temperatures are generally high, reaching 50°C at times in summer—the main problem is prolonged hot periods (over 35°C) through the summer, when the relative humidity is also often high. Duration of the experiment was from June to September 2022. Four cucumber genotypes (IC257296, IC420405, GYNE-5, PUSA SANYOG) obtained from the NBPGR, New Delhi, India were used for the study. They were evaluated in a randomized complete block design (RCBD) with two replicates. The field was prepared and divided into two blocks. The crop was seeded directly after the soil was well prepared. Fertilizers, Irrigation and Pest management were done on proper time and using standard agronomical practices. Half dose of fertilizers was applied at the time of sowing and half after 28 days. Randomly five plants from each row were selected for data. Growth traits were measured 8 weeks after planting and yield traits measured immediately after harvest. These traits included germination %age, days to 50% flowering, days to fruit initiation, days to edible maturity, Vine Length, fruits per plant, fruits per kilogram, fruit length, fruit width and total fruit yield per hectare.

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The table of climate characteristics of the region should be added
Agricultural practices should be fully explained
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2. **Statistical Analysis**

Correlation analysis was performed for quantitative data and analysis of variance (ANOVA) was done by Scilab (Campbell et.al., 2010).

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RESULTS AND DISCUSSION

All the genotypes exhibited variable phenotypic traits when sown in different agro-climatic zones. Among phenotypic traits, %age germination depicted variability among the genotypes

(Table 1). In Indian soil, maximum germination (67.5%) was recorded for genotype IC420405 while minimum (50.0%) in genotype PUSA SANYOG, whereas, in Qatar soil, PUSA SANYOG recorded highest (62.5%), while, IC257296 recorded lowest (27.5%). Similarly, the genotypes showed variation in days to half flowering i.e. 50% flowering. Greatest number of days (41.5 & 43.5) to 50% flowering was recorded for genotypes PUSA SANYOG and GYNE-5 in India and Qatar, respectively, whereas minimum number of days (37.5 and 35.5) was recorded for genotypes IC257296 and PUSA SANYOG in India and Qatar, respectively. From the (Table 1) it is evident that the genotype PUSA SANYOG took maximum number of days (54.5 and 50.5) for fruit initiation and genotype420405 took least *i.e* 43.5 and 44.0 days, respectively. These results are in accordance with the finding of Ahmed et al., (2004) and Hamid et al., (2002). These variations in traits such as seed germination, 50% flowering days, days to fruit initiation could be possibly due to genetic makeup of the cultivars, which responded differently to the environmental conditions.

The genotypes displayed significant variation (Table 1) for days to edible maturity. Greater number of days (67.5 and 66.5) was recorded for genotype PUSA SANYOG in India & Qatar, respectively while lowest number of days (57.5) was recorded for genotype 257296 in India, whereas 61.5 in genotypes GYNE-5 & 420405. Our results were supported with findings of Resende (1999) and Ahmed et al., (2004) who concluded that major variability is present in days to edible maturity due to the genetic differences in genotypes of cucumber. Vine length presented in Table 1 varied greatly among all cucumber genotypes. Genotype GYNE-5 and PUSA SANYOG recorded maximum vine length (195.4 and 200 cm) in India and Qatar, respectively and genotype 420405 showed minimum vine length (120.85 cm). Our findings are similar with Abusalena and Dutta, (1990) and Hossain et al., (2010) who also studied vine length and found great variation in it. This variability shows that a great genetic diversity is present among cucumber genotypes. In both climatic zones of India & Qatar, Vine length was found to be positively correlated with total number of fruit per plant and fruit width, whereas, it showed non-significant correlation with other traits (Table 3 and Table 4). These results are also in accordance with the study of Hossain et al., (2010) and Abusalena and Dutta (1988) who also concluded that vine length have positive significantly correlated with fruit width and total number of fruit per plant because of the increase in the number of nodes for fruit initiation. Significant variability was present in fruit per plant among all genotypes.

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The maximum number of fruits per plant was present in genotype GYNE-5 (9.10) in India and PUSA SANYOG (10.8) in Qatar zone, while the minimum number of fruits per plant was present in genotype 420405 in both zones as shown in Table 1. Hossain et al., (2010) also reported that variation in number of fruit per plant among the accessionsmay be due to the different environmental conditions orthe genetic variation. Total number of fruit per plant showed positive significant relationship with vine length and fruit width (Table 3 and Table 4). Hossain et al., (2010) and Abusalena and Dutta, (1988) who also reported that a significant positive correlation was present between total number of fruit per plant, vine length and fruit width.

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Fruit per kilogram reveal significant variation between the genotypes as shown in Table 1. Genotype 420405 showed the maximum number of fruit per kg in both Indian and Qatar zone, whereas, genotype GYNE-5 showed minimum number (3.65) of fruits per kg. Our results are accordance with Hamid et al.,(2002) who concluded that genotypic variation among cucumber genotypes is present when considering fruit per kg trait. In this study, fruit length showed great variation among all the genotypes. Genotype 257296 and PUSA SANYOG recorded the highest fruit length (18.22 and 20.43 cm) in India and Qatar, respectively. While the genotype 420405 recorded the lowest length of fruit as shown in Table 1.These results are agreed to that obtained by Sharma et al.,(2000), Prasad and Singh (1994), Hormuzdi and More, (1989) and Hossain et al., (2010) who also found significant differences in fruit length in their study. The fruit width data shown in Table 1 revealed that different cucumber genotypes exhibit significant differences. Greater fruit width was shown by genotype PUSA SANYOG in both climatic zones. On the other hand, cucumber genotype 420405 showed lowest fruit width. Variation in fruit width was also reported by Saha et. al., (1992) and Hossain et al., (2010) in their study. A strong positive correlation was present between fruits width and fruit length in both zones (Table 3 and Table 4). These results are supported by the study of Eifediyi et al., (2011) who also found positive significant relationship among fruit width and fruit length. Fruit length is also positively correlated with yield tons/ha. Result of the correlation analysis represents that yield was positively correlated with vine length (Table 3 and Table 4). Ballesta-Jimenez (2018) suggested that soil quality assessment is a new tool for evaluation and monitoring the production systems in terms of different agro-climatic zones. The soil quality and agro-climatic conditions of Meerut (India) and Doha (Qatar) markedly differ which suggest that the differences in varietal yield

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during our studies may be because of both soil quality as well as agro-climatic conditions. Lawal (2000) concluded very high positive correlation between cucumber genotypes in relation to fruit length and fruit yield. Further, Eifediyi et al., (2011) found no significant positive correlation between fruit width and fruit yield. Fruit width also positively correlated with total number of fruit per plant. Hossain et al., (2010) who found no relationship between fruit width and total number of fruit per plant. These variations are due to the differences in environmental conditions, the genetic diversity of genotypes, or the presence of available nutrients. Sallam et al. (2021) have reported that the use of poultry manure and minerals as fertilizers can enhance the productivity of cucumber under greenhouse conditions. Our study suggest that the changes induced due to agro-climatic conditions may be encountered using green manure and minerals rich fertilizers. Cucumber is rich in minerals, vitamins and anti-oxidants, hence the supplementation of minerals rich fertilizers will logically improve the quality and yield of cucumber. Lalnunkimi et al (2022) while evaluating eight genotypes of cucumber under Prayagraj agro-climatic conditions found that Sunny-85 was highly cost effective. It suggests that the varietal trials under different agro-climatic conditions yield highly useful information that may enhance the cost benefit ratio of farmers and may improve better financial gains for the farmers. Prathyusha (2020) and Singh and Shaju et al (2020) while studying the varietal evaluation of different varieties of cucumber in Prayagraj found that different varieties respond differently under similar agro-climatic zones. It, is thus, safely concluded the prior trial studies of different varieties under different soil conditions and different agro-climatic zones should be conducted using different manures and mineral fertilizers to get the best yields of high quality.

Conclusions:

In summary, comparing phenotypic pattern of different cucumber genotypes in both different agro-climatic zones, maximum germination has been observed in the genotype GYNE-5 and PUSA SANYOG. These genotypes have also shown early days to maturity and maximum fruit length, thus, can be chosen for business production in Qatar. On the other hand, in PUSA SANYOG highest yield was observed in Qatar climatic zone. Based on these results, these genotypes are found suitable and these genotypes should be grown in other areas of India and

Qatar and must be characterized at using molecular markers such as SSR, RFLP etc. to investigate environmental influence on yield.

Table 1: Variation in Quantitative characteristics among cucumber genotypes when grown in Qatar and India climatic zones

Genotypes	Germination % age	days to 50 % flowering	days to fruit initiation	days to edible maturity	Vine Length (cm)	fruits per plant	fruits per kilogram	fruit Length (cm)	fruit width (cm)
In INDIA									
IC257296	65.0	37.5	44.5	57.5	168.75	7.40	5.20	18.22	4.84
IC420405	67.5	39.5	43.5	59.0	142.05	6.30	5.40	18.09	4.80
GYNE-5	62.5	39.0	46.5	64.5	195.40	9.10	5.15	17.84	5.70
PUSA SANYOG	50.0	41.5	47.5	67.5	150.85	6.80	4.85	17.51	6.05
In QATAR									
IC257296	27.5	38.0	44.5	64.5	138.90	6.10	4.80	18.98	5.75
IC420405	47.5	42.5	44.0	61.5	130.60	5.20	5.70	17.32	5.00
PUSA SANYOG	62.5	35.5	50.5	66.5	200.15	10.8	3.70	20.43	6.40
GYNE-5	32.5	43.5	45.0	61.5	169.00	7.50	3.65	18.34	5.85

Table 2: **Variation in Yield among cucumber genotypes when grown in Qatar and India climatic zones**

Genotypes	yield (Tons ha^{-1})
In INDIA	
IC257296	7.40
IC420405	8.80
GYNE-5	9.35
PUSA SANYOG	7.30
In QATAR	
IC257296	3.65
IC420405	4.65
PUSA SANYOG	8.00
GYNE-5	4.25

Table 3: **Correlation analysis of cucumber genotypes in Indian climatic zone**

	VL	FL	FW	TNF/P	Y ton/ha
VL	1				
FL	.269	1			
FW	.452*	.611**	1		
TNF/P	.995**	.350	.514*	1	
Y ton/ha	.264	.521**	.439*	.267	1

Note: **=Correlation is significant at the 0.01 level, *=Correlation is significant at the 0.05 level, ns=Non significant, VL= Vine length, FL=Fruit Length, FW=Fruit Width, TNF/P=Total number of fruits per plant, Y ton/ha=Yield tons per hectare

Table 4: **Correlation analysis of cucumber genotypes in Qatar climatic zone**

	VL	FL	FW	TNF/P	Y ton/ha
VL	1				
FL	.223	1			
FW	.398*	.597**	1		
TNF/P	.974**	.353	.524*	1	
Y ton/ha	.274	.512**	.435*	.312	1

Note: **=Correlation is significant at the 0.01 level, *=Correlation is significant at the 0.05 level, ns=Non significant, VL= Vine length, FL=Fruit Length, FW=Fruit Width, TNF/P=Total number of fruits per plant, Y ton/ha=Yield tons per hectare

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Comment [A12]: Update

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