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Evaluation of Yield and Yield Attributes of Fenugreek (*Trigonella foenum graecum*) Genotypes under Drought Conditions

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ABSTRACT

Drought is one of the major environmental constraints for the agriculture crop worldwide and overcome yield penalty under drought situations, is the major goal for agriculturist in future. To achieve this goal, screenings of landraces are one of the most important genetic resources for crops improvement especially in dry areas. The present study was carried out during 2015-2016, in order to evaluate drought tolerance in eight fenugreek genotypes, under both control and drought conditions, and various parameters were recorded at flowering and pod formation stage. The experiment was laid out in randomized block design with replicated thrice. Yield and yield attributes viz. Days to 50 percent flowering, Number of pods per plant, Number of seed per pod, Test weight, Plant height (at harvest), Seed yield and Biological yield were used to assess drought tolerance in fenugreek genotypes. Ranking of genotypes based on SY at both flowering and pod formation stage showed that Rmt-1 and Rmt-305 variety has the highest SY among the tested genotypes under control and drought condition.

Key words: *Drought, Pod formation stage, Test weight, SY (Seed Yield).*

INTRODUCTION

Fenugreek is an annual herb that belongs to the family *Fabaceae* and subfamily *Papilionaceae*, widely grown in Egypt and Middle Eastern countries[3,11]. Fenugreek leaves and seeds are widely consumed as a spice in food preparation because of its strong flavor and aromaand also used as an ingredient in traditional medicine[12]. Fenugreek leaves and seeds are consumed in different countries around the world for different purposes such as medicinal uses (Estrogenic, anti-diabetic, lowering blood sugar and cholesterol level, anti-cancer, anti-microbial *etc.*)[1,13,14,15]. It also used as food additive in many countries as stew with rice in Iran, flavor cheese in Switzerland, syrup and bitter run in Germany, mixed seed powder with flour for making flat bread in Egypt, curries, dyes, young seedlings eaten as a vegetable, roasted grain as coffee-substitute in Africa[12].

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The germinated seeds of fenugreek contain Leucine, Lysine and L-tryptophan rich proteins, mucilaginous fiber and other rare chemical and antioxidants like saponins, coumarin, fenugreekine, nicotinic acid, sapogenins, phytic acid, scopoletin and trigonelline, which are thought to account for many of its presumed therapeutic effects, may inhibit cholesterol absorption and to help lower sugar levels[7]. Nutrient analysis of fenugreek showed thatit is rich source of calcium, iron, alpha-carotene and other vitamins[9]. Fenugreek can be a very useful legume crop for short-termcrop rotation as it fixes nitrogen in the soil.

Drought is one the most important limiting factor for crop production and it is becoming a severe problem in many regions of the world. Drought is one of the major physical parameter of an environment, which determines the success or failure of plants establishment. Generally drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by evapotranspiration[2]. Nevertheless, drought tolerance is a complex quantative trait resulting from the contribution of numerous factors[5]. Drought stress has adverse effect on plant growth, Days to 50 percent flowering, Number of pods per plant, Number of seed per pod, Test weight, Plant height (at harvest) ,Seed yield and Biological yield. Landraces are the important genetic resources for improvement of crops in dry areas, since they have accumulated adaptation to harsh environment over long period. Collection and characterization of various agronomic and physiological traits of landraces are primary steps in abiotic stress tolerance programme.

With this background, the proposed research studies was planned to understand the Yield and yield attributes that occurs in contrasting fenugreek genotypes under normal and water stress conditions. It is hypothesized that this information will help the plant biologists and plant breeders in developing drought tolerant fenugreek genotype in near future.

MATERIALS AND METHODS

Seeds of Fenugreek genotypes obtained from Durgapura research station were used for present study purpose. The experiment was conducted at Research Farm, S.K.N. College of Agriculture, Jobner (26^{o} 05' N and 75^{o} 28' E, 427 m above mean sea level) during *rabi* season of 2015-16. The soil of the experimental site was loamy sand in texture, slightly alkaline in reaction. Mean annual precipitation and mean annual temperature during crop season were 400 mm and 15.5°C, respectively. Treatments are maintained by withdrawing irrigation at regular interval. Eight fenugreek genotypes were evaluated using randomized block design (RBD) with three replications under irrigation (every two weeks) and drought stress (one irrigation after sowing and rainfall during the season till maturity of 50% of plants in each plot). The crop was sown on 9th November.

Several yield and yield attributes were measured calculated using the following formula:

- **Days to 50 percent flowering:**

When the days to 50 percent flowers appeared in the plot, the date was recorded and number of days from the date of planting was calculated.

- **Number of pods per plant**

The number of pods were counted from five randomly selected plant in each plot and then the average was calculated.

- **Number of seeds per pod**

The total number of seeds of the pods were counted and calculate the number of seeds per pod.

- **Test weight (1000 seed weight) :**

One thousand seeds were counted from each sample drawn from the finally winnowed and cleaned produce of each plot and their weight was recorded as test weight (g).

- **Plant height at harvest:**

At harvest the height of five randomly selected plants was measured from base to top of the plant with the help of the meter scale and mean plant height was worked out.

- **Seed yield:**

After threshing and winnowing, the clean seeds obtained from the produce of individual plot were weighed and weight as seed yield g/plant.

- **Biological yield:**

The weight of the thoroughly sun dried harvested produce of each plot was recorded separately before threshing and expressed as biological yield in g/plant.

- **Drought susceptibility index:** DSI% = $(1-YS/YP)(1-Y_S/Y_P)$ x 100

Y_S = Yield of cultivar under stress, Y_P = Yield of cultivar under irrigated condition, Y_S = Mean yield of cultivar under stress, Y_P = yield of cultivar under irrigated condition.

Statistical analysis

All the observation was taken in each genotypes, replications and sets. The data was statistically analysed according to Panse and Sukhatme[10].

RESULTS

Days to 50 percent flowering: Days to 50% flowering was observed under both control and drought conditions. In **fig 1** minimum days to 50% flowering observed in genotype was Rmt-365 35.34 days (control) and Rmt-1 33.54 days (drought), while highest in Rmt-351 49.23 days (control) and Rmt-365 44.32 days (drought). Under drought condition percent reduction was highest in Rmt-143 25.38% and lowest in Rmt-354 2.54, while Rmt-303 and Rmt-365 show more yield in drought conditions than control conditions.

Number of pods per plant: Number of pods per plant showed under control and drought conditions. In **fig 2** maximum number of pods per plant observed in Rmt-303 45.30 (control) and Rmt-1 35.54 (drought), While lowest in Rmt-351 34.54 (control) and Rmt-351 30.93 (drought). Under drought condition percent reduction was highest in Rmt-303 28.16% and lowest in Rmt-305 2.65 %.

Number of seeds per pod: Number of seeds per pod counted under control and drought conditions. In **fig 3** maximum number of seeds per pod in variety Rmt-303 16.24 (control) and Rmt-1 14.32 (drought), While lowest in Rmt-143 10.23 (control) and Rmt-365 7.84(drought). Under drought condition percent reduction was highest in Rmt-303 49.26% and lowest in Rmt-1 0.83% while Rmt-361 showed more yield under control and drought condition.

Test weight (1000 seed weight): Test weight was measured in control and drought conditions. In **fig 4** highest test weight was observed in Rmt-303 13.39 (control) and Rmt-1 12.59 (drought), while lowest test weight in Rmt-143 12.09(control) and Rmt-354 11.34 (drought). Under drought condition percent reduction was highest in Rmt-365 13.62% and lowest in Rmt-143 0.90%.

Seed yield (g plant^{-1}): Seed yield per plant observed in all genotype under both control and drought conditions and it was found that in control condition highest seed yield from genotype Rmt-303 7.02 followed by Rmt-365 6.98, while lowest in Rmt-143 6.30 followed by Rmt-361 6.45. Under drought highest seed yield was observed in genotype Rmt-1 6.24 followed by Rmt-305, while lowest in Rmt-354 5.08 followed by Rmt-143 5.19 g plant^{-1}. SPSS analysis showed significant difference between genotype under drought condition but under control data were non-significant. Observations on seed yield plant^{-1} under control and drought conditions are represented in **Table 2**.

Biological yield (g plant^{-1}): Biological yield was observed in all genotypes under both control and drought conditions and data showed that Under control condition variety Rmt-303 26.20 recorded maximum biological yield closely followed by Rmt-365 26.10 while lowest in Rmt-351 25.20 followed by Rmt-361 25.40. Under drought condition maximum biological yield was observed in Rmt-1 25.10 followed by Rmt-305 (24.50g), while while lowest in Rmt-143 22.80 followed by Rmt-354 22.90 showed in **fig 5**

Drought susceptibility index: Data presented in **fig 6** showed that Drought susceptibility index varied significantly among the genotypes. The lowest DSI was noted in the variety Rmt-305 (0.48) followed by Rmt-361 (0.49). The highest DSI was noted in the variety Rmt-354 (1.70) followed by Rmt-365 (1.46).

Table I is representing the seed yield (g plant^{-1}) of fenugreek genotypes at harvesting stage. Presented data in table are the mean of three replication and ± represent standard deviation between replication. Within each genotypes different letters indicate significant difference by Duncan`s multiple test at P<0.05.

Seed yield (gplant^{-1})			
Sr. No.	**Name of Genotype**	**Control**	**Drought**
1	Rmt-1	6.90±^{a}	6.24±^{a}
2	Rmt-143	6.30±^{a}	5.19±^{a,b}
3	Rmt-303	7.02±^{a}	5.85±^{a,b}
4	Rmt-305	6.55±^{a}	6.08±^{a,b}
5	Rmt-351	6.70±^{a}	5.80±^{a,b}
6	Rmt-354	6.82±^{a}	5.08±^{b}
7	Rmt-361	6.45±^{a}	5.98±^{a,b}
8	Rmt-365	6.98±^{a}	5.45±^{a,b}

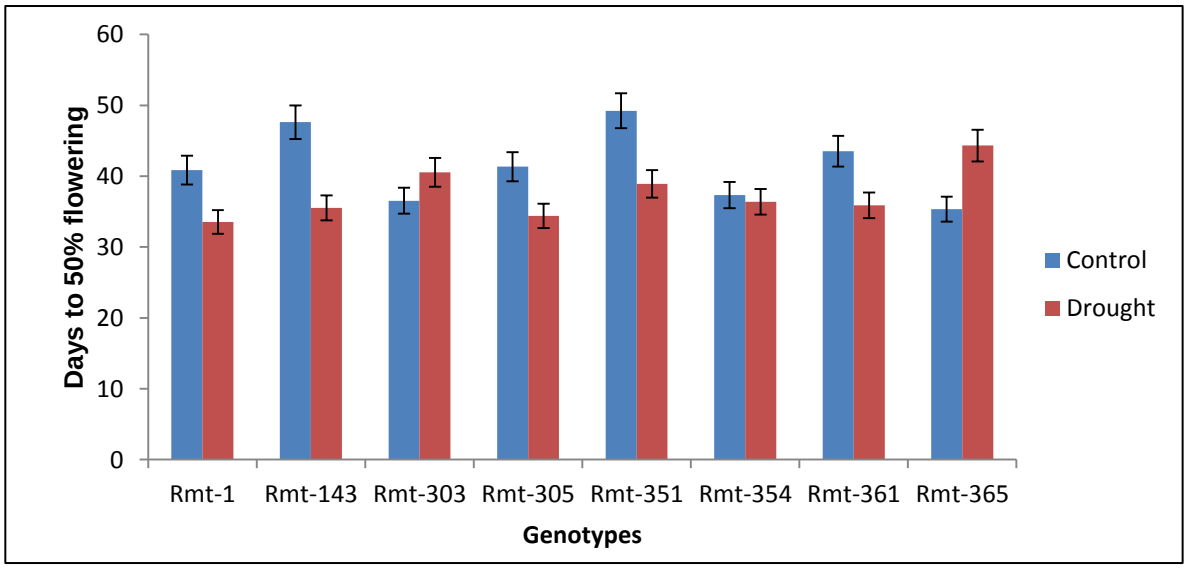

Fig. 1: is representing the Days to 50% flowering of fenugreek genotype. Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

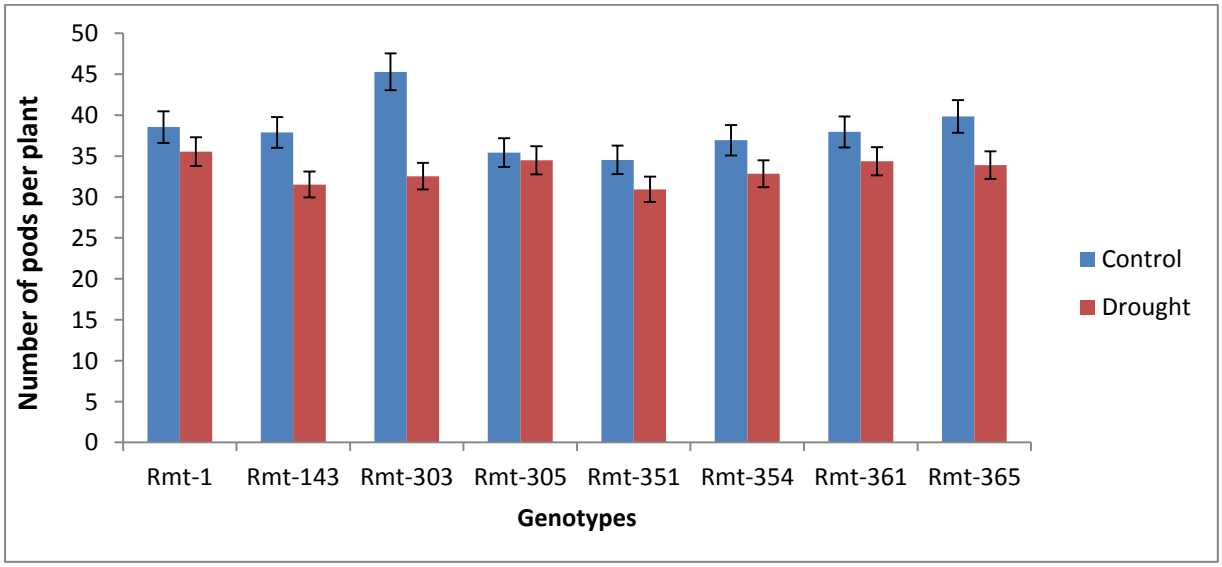

Fig. 2: is representing the number of pod per plant of fenugreek genotype . Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

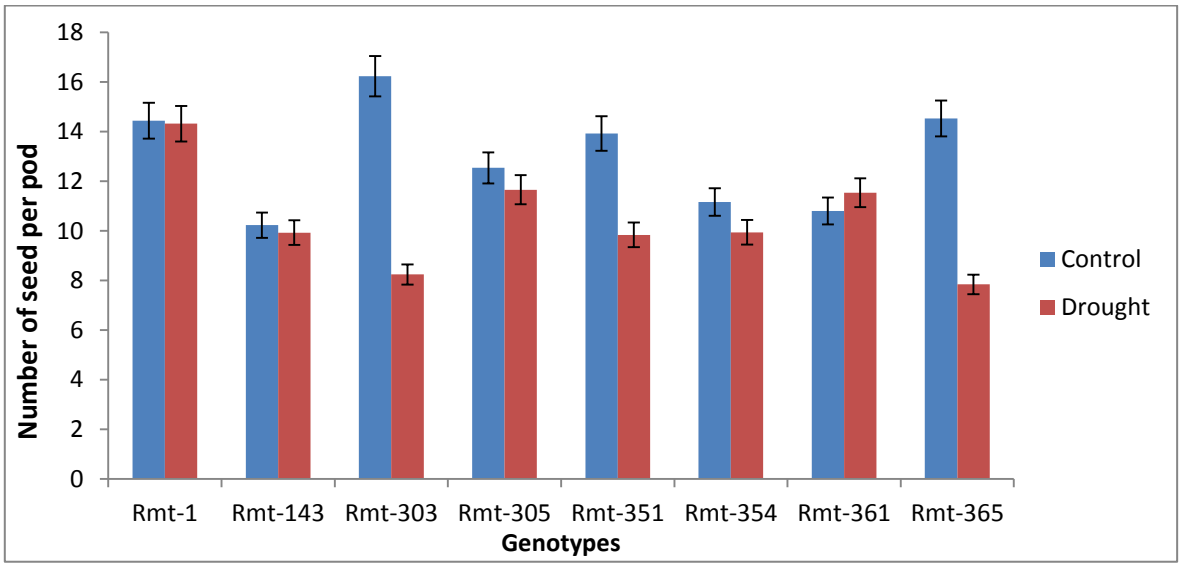

Fig. 3: is representing the number of seed per pod of fenugreek genotype. Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

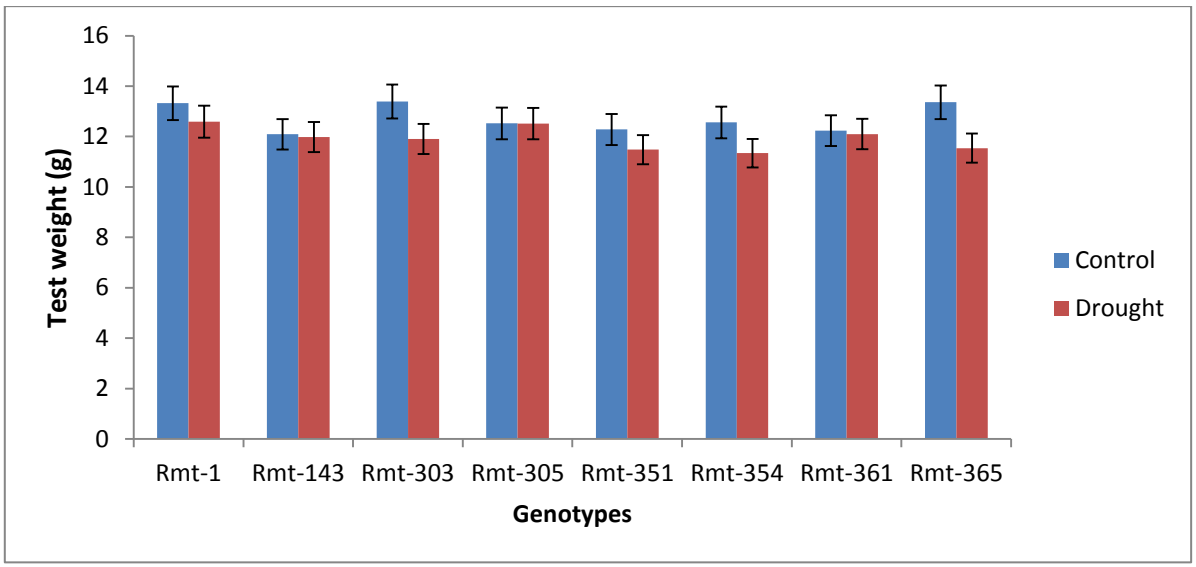

Fig. 4: is representing the test weight (g) of fenugreek genotype. Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

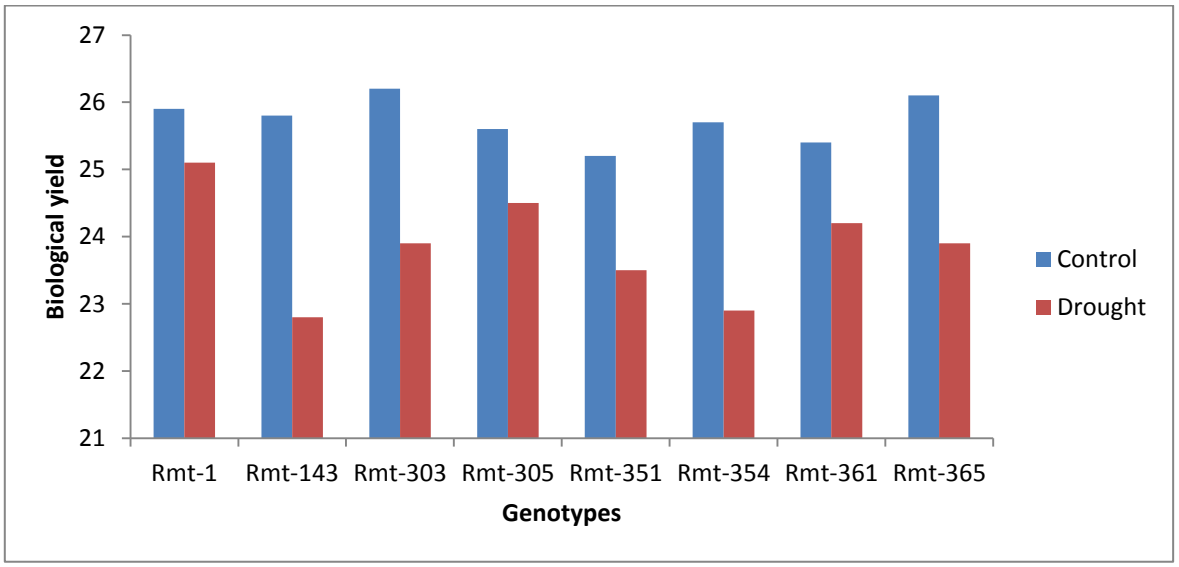

Fig. 5: is representing the biological yield (g) of fenugreek genotype. Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

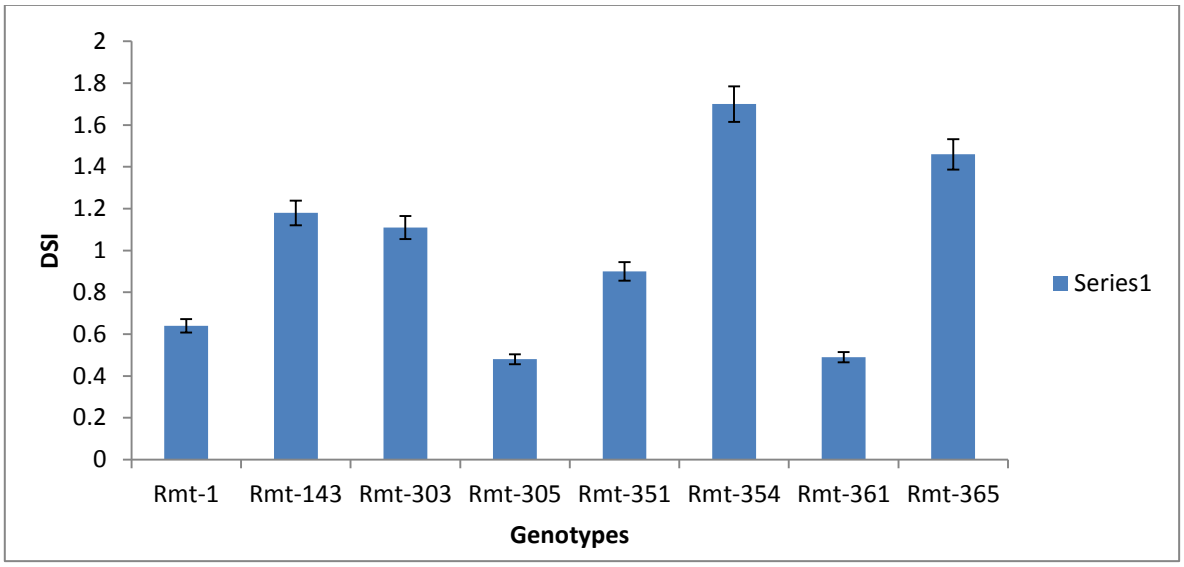

Fig. 6: is representing the DSI of fenugreek genotype. Presented data in graph are the mean of three replication and error bar represent standard deviation @ 5% between replication.

DISCUSSION

Water is one of the major environmental constrain which limites the crop production. Fenugreek crop responds to water deficit in the form of changes in various physiological, biochemical and molecular processes. In the present study, with eight genotypes varying in field performance in response to water stress, yield and yield attributes are evaluated. All these parameters helped in assessing tolerant versus susceptible genotypes at yield levels between the two critical stages of water stress.

Yield is the most important parameters for a crop. However, the yield contributing parameters are different in cereals, seed spices and pulses. In case of fenugreek we have measured the plant height, day to flowering, number of pods per plant, number of seeds per pod, test weight, seed yield, biological yield, harvest index in eight fenugreek varieties.

Result of present study showed that the days to 50% flowering was non-significantly correlated with yield in all the genotypes during drought condition. Exposure

of plants to drought stress substantially increased no of days to 50% flowering .In present investigation a non significant correlation of days to 50% flowering with seed yield was observed. This reduction in yield indicates that drought condition caused some metabolic changes in the fenugreek plants conversion from vegetative phase to reproductive phase.

Water stress decreased number of pods per plant at 50 per cent flowering stage in chickpea[6]. Water stress induced reduction in growth parameters was also reflected in number of seeds per pod, number of pods per plant and seed index. Number of pods per plant and number of seed per pods shows positively correlated with seed yield and maximum number of pods per plant and number of seed per pods show highest yield.

Water stress caused decrease in biological yield as compared to non stress condition. Biological yield is an important criterion for improvement in yield, which is strongly influenced by the environment[8]. In case of harvest index as an important criterion for improvement in the yield, which is strongly influenced by environment?

Drought susceptibility of a genotype is often measured as a function of the reduction in yield under drought stress[4]. Yield is the most important parameter for a crop. However, the yield contributing parameters are different in cereals, pulses, oilseed and seed spices crops. In case of fenugreek, we have measured yield in control as well as water stress condition. In the present study, there is reduction in yield due to water stress at both the stages. The decrease was more in pod formation as compared to flowering in water stress. In the present study, genotypes Rmt-1 and Rmt-305 were less affected by water stress at both the stages. These results are supported by other parameters studied in this study.

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