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Assessment of drought tolerant and high yielding groundnut varieties in Dindigul district

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Abstract
Three varieties of groundnut were used to assess the drought tolerance and high yielding potential. Groundnut (*Arachis hypogaea* L.) is an important oil seed crop mainly grown under rainfed situation. Due to erratic rainfall and frequent drought during the crop growth period, groundnut yields are generally low and unstable under rainfed conditions. Drought during critical crop growth stages is crucial for yield in groundnut varieties. But tolerant genotypes may give better yield due tomaintenance of physiological responses that were triggered during drought. On Farm Trials was conducted by Krishi Vigyan Kendra, Dindigul to assess suitable drought tolerant and high yielding groundnut variety in terms of yield, acceptability and adoption potential during Kharif 2017-18 in Dindigul district. The study revealed that CO 7 recorded higher pod yield (1990 kg/ ha), higher number of pods/plant (23) and optimum plant population (26.5 plants/m^2) as compared to farmers practice. Gross and net returns were Rs.89,550/- and Rs.49,550/-ha, respectively by cultivating CO 7 as against Rs.59,850/- and Rs.16,250/-ha in the check variety. CO 7, kadiri 9 and KCG 6 would be a better option for rainfed cultivation in Dindigul district.

Keywords: Groundnut, pod yield, rain fed, drought

Introduction
Groundnut, the king of oil seeds is one of the important legume crops cultivated predominantly under rain-fed conditions in the tropical and semi-arid tropical countries including India, where it provides a major source of oil, carbohydrates and proteins (Bhauso *et al.*, 2014) [6]. The seed is used mainly for edible oil and contains nearly half of the essential vitamins and one-third of the essential minerals. It is one of the most nourishing foods available in the world. Apart from their nutritional value, groundnut has considerable medicinal value. It is consumed in many ways and various forms. Due to its high monosaturated content, it is considered healthier than saturated oils and is resistant to rancidity. Groundnut is particularly valued for its protein content (26%). In addition to protein and oil, groundnut is a good source of Ca, P, Fe, Zn and B. Hence, groundnut played an important role in nutritional security to the resource poor farmers. In addition, the haulms provided excellent fodder for livestock, cake obtained after oil extraction was used in animal feed and overall the crop acted as good source of biological nitrogen fixation (Nautiyal *et al*, 2011) [15].
Groundnut is the sixth most important oilseed crop in the world. Globally, the crop is raised in 25.7 million hectares with a total production of 37.1 million MT. The average productivity is 1400 kg/ha. India shares 22 per cent of the world production (area 4.8 m.ha, production 5.9 MT).The area under rainfed groundnut in Tamil Nadu is 4.4 lakh hectares with a production of 9.11 lakh tones during *Kharif* 2017-18.
Groundnut is cultivated predominantly in the tropics and subtropics, where the availability of water is a major constraint on yield (Viramani and Singh, 1986) [22]. During the entire season, the crop is subjected to water deficit stress at one stage or another leading to drastic reduction in productivity. This necessitates development of cultivars which can withstand water stress and still can be productive. Reduction in peanut yield resulting from drought has been well documented (Nageswara Rao *et al*., 1989 and Reddy *et al*., 2003) [13, 17]. Drought during the pod and seed forming stages has been shown to reduce pod yield of peanut by 56-85% (Nageswara Rao *et al*., 1989) [13]. Hence, the study was planned with the objectives to evaluate the improved groundnut varieties with high yield and drought tolerance under kharif season through on farm trials in Dindigul district.

Materials and Methods

Conduct of On-Farm Trial (OFT) is the foremost man date of Krishi Vigyan Kendra across India to assess the technology under particular agro ecosystem or at district level. On-farm trials are being conducted on farmers' participatory mode during kharif 2017 with five farmers from Marampadi village in Vedasanthur block of Dindigul district. Sowing was performed under rainfed condition, depending on the onset of monsoon, sowing was completed within the first week of August in the all fields. The soil was sandy clay loam in texture with pH 7.0. The fertility status of the soil was low, medium and high in the available N, P_2O_5, and K_2O, the values are 179, 23 & 408 kg ha^{-1} respectively. The farmers were sowing the country plough behind the manual sowing practice. The experiment was laid out in a randomized block design (RBD) with three replications. Three improved groundnut varieties viz. CO 7, Kadiri 9, KCG 6 (Table 1) and check variety viz. JL 6 and VRI 2 in the trial were taken for study. The recommended package of practices for groundnut cultivation followed as per TNAU recommendations. The data on germination per cent, plant population, physiological parameters, No. of pods/ plant, pod yield, haulm yield and economics of all the varieties were recorded.

Observations on growth characters such as plant height, leaf area index and dry matter production were recorded at 40, 80 DAS and at harvest from five randomly selected plants in each plot. The samples were collected from sampling rows in each plot for dry matter production and were used for the estimation of DMP. The data obtained from experiments were subjected to statistical analysis by using the statistical software AGRES.

Crop Growth Rate

The mean CGR was calculated as suggested by Watson (1958) [23] using the formula

$$\text{CGR (g m}^{-2}\text{ day)} = \frac{W_2 - W_1}{(t_2 - t_1)}$$

where, W_1 and W_2 were the dry weight of plants in g at times t_1 and t_2 respectively.

Leaf Area Index

LAI was calculated using the following formula as suggested by Ashley *et al*. (1963) [2].

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Land area (cm}^2\text{) occupied by one plant}}$$

Relative Leaf Water Content

Relative leaf water content was estimated as suggested by Barrs and Weatherley (1962) [3]. Fully expanded third leaf of comparable age and orientation at the top was collected before irrigation cycles. Two gram (fresh weight) was weighed from the leaf discs and was floated in distilled water for four hours; then surface dried using tissue paper and weighed (leaf turgid weight). The dry weight was obtained by drying leaf discs in an oven at 65 ± 5^0 C which is sufficiently long to dry the discs to constant weight.

The RLWC was calculated from the formula given below

$$\text{RLWC (\%)} = \frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Turgid weight (g)} - \text{Dry weight (g)}} \times 100$$

Chlorophyll content

Chlorophyll content of leaves was determined as per the method of Arnon (1949) [1]. The leaf tissues were extracted in 80% acetone. The absorbance was read at 663 nm and 645 nm on spectrophotometer. The chlorophyll content was calculated (mg of chlorophyll per g of tissue) using formula, mg of total chlorophyll = 20.2 (A 645) + 8.02 (A 663)× V/1000 x weight of sample.

Proline content

Proline content was estimated as per the method described by Bates *et al*., (1973) [4] and expressed as µ mole per g FW by measuring absorbance at 520 nm with toluene as blank.

Results and Discussion

Growth parameters: With regard to evaluation of groundnut varieties significant difference were observed on plant height at 80 DAS and at harvest stage, Co 7 recorded the highest value for plant height of 38.5 cm and 44.5 cm at 80 DAS and at harvest stages, respectively (Table 1). It was least in farmer practice at 80 DAS and at harvest. Higher plant height in CO 7 may be attributed to the variety which tends to germinate and establish early compared to farmer practice varieties with medium and small seeds. Similar increase in plant height with large seeds was also observed by Singh *et al*. (1998) [19] and Nandania *et al.* (1992) [14]. Mensah and Okpere (2000) [12] showed the significant differences among the different varieties of groundnut for plant height throughout the growth period.

Physiological parameters: The pattern of dry matter production and its distribution into component plant parts has been of phenomenal interest to the research workers engaged in yield analysis. In the present investigation, it envisaged to know the pattern of dry matter accumulation, it's distribution in component parts of plant (Table 1). The variety, CO 7 (4250 kg/ha) maintained the highest dry matter production as an account of higher magnitude of dry matter in leaves, stem and roots. In addition, Kadiri 9 and KCG 6 were also recorded highest dry matter production of 3910 kg/ha and 3620 kg/ha respectively.

Among varieties (CO7) recorded higher relative leaf water content (RLWC) of 68.5 at flowering stage. The lowest relative leaf water content was recorded in farmer's practice. The highest reduction was recorded in farmer practice (47.5 per cent). Bars and Weatherley (1962) [3] suggested that RWC under stress condition could be used as measure of tolerance to stress. Decline of RWC under drought stress was observed earlier in groundnut by Sharda and Naik (2011) [9]. This might be due to reduction in water availability, stomata opening and closing is more affected. Similar results have been reported in groundnut (Madhusudhan and Sudhakar, 2014) [10], in horsegram (Bhardwaj and Yadav, 2012) [5] and in pigeonpea (Kumar *et al.*, 2011) [9]. The results obtained in the present study are in agreement with these reports.

The chlorophyll content also decreased significantly under stressed condition in all genotypes of groundnut. Chlorophyll content of water stressed plants it was found to be decreased from 1.25 to 1.9 mg/g (Table 2).The minimum decrease of 1.91 was observed in CO 7 while unknown farmers variety recorded higher decline of 1.25 (Table 2). It has been reported that the loss of chlorophyll under water stress is due to inactivation of photosynthesis (Kumar *et al*., 2011) [9], furthermore, stress induced reduction is ascribed to loss of chloroplast membrane integrity due to lipid peroxidation

(Manivannan *et al*., 2007) [11]. The decrease of photosynthetic pigment under water limitation has been considered a typical symptom of oxidative stress and may be result of pigment photo-oxidation and chlorophyll degradation and prevent its biosynthesis have been reported in peanut (Farooq *et al.*, 2009; Sharada and Naik 2011; Kumar *et al.*, 2011; Madhusudhan and Sudhakar, 2014) [7, 18, 9, 10].

Plants accumulate osmolytes through biochemical mechanisms such as proline which improve their ability to withstand stress. Imposing water stress resulted a more than 50 per cent increase proline content i.e 17.2 to 24.3 µ mol per g fr. wt (Table 2). The highest proline accumulated in CO 7, KCG 6 and Kadiri 9 respectively. In terms of percent increase over control the maximum per cent increase was observed in genotype CO 7 followed by, KCG 6 and Kadiri 9 and the least in farmer practice. In present investigation higher concentration of proline indicate an efficient mechanism for osmotic regulation, stabilization of cellular structure and adaption to water stress which is in agreement with the earlier reports (Gunes *et al.*, 2008; Solanki and Sarangi, 2014) [8, 20]. It is also associated with lower levels of RWC. Our results of proline accumulation are in agreement with the results of reported in groundnut (Madhusudhan and Sudhakar, 2014) [10], in horse gram (Bhardwaj and Yadav, 2012) [5].

Yield and Economics

On-farm trials revealed that groundnut variety CO 7 recorded higher pod yield (1990 kg/ ha), higher number of pods/plant (23), lesser root rot incidence (1.4%) and optimum plant population (26.5 plants/m^2) as compared to Kadiri 9 and farmer practice variety (Table 3). Groundnut varieties, CO 7 and KCG 6 recorded 49.6 and 41.3 per cent higher pod yield than check variety, respectively. With regard to haulm yield, CO 7 variety recorded highest haulm yield of 4335 kg/ha as compared to other varieties.

Gross and net returns were Rs.89,550/- and Rs.49,550/- ha, respectively by cultivating CO 7 as against Rs.59,850/- and Rs.16,250/-ha in the farmers variety. The probable reason were drought withstand genotype and lesser incidence of root rot disease coupled with higher number of pods/plant resulting higher pod and haulm yield, these results were in agreement with the findings of Vindhiyavarman *et al*. (2010).

Conclusion

Groundnut variety, CO 7 recorded more number of pods per plant, higher pod yield, good withstand under drought and performed very well compared to Kadiri 9, KCG 6 and farmer practice variety under rainfed condition. Farmers were very satisfied with CO 7, as the crop did not suffer from a dry spell of 17-21 days without rain. So, groundnut variety CO 7 would be better option for rainfed cultivation during kharif season in Dindigul district.

Table 1: Growth performance on groundnut varieties in farmer's field

Variety	40 DAS				80 DAS					At harvest(110 DAS)				
	Germination percentage (%)	Plant height (cm)	DMP (kg/ha)	LAI	Plant population/m^2	Plant height (cm)	DMP (kg/ha)	LAI	CGR (gm^{-2} day)	Plant population/m^2	Plant height (cm)	DMP (kg/ha)	LAI	CGR (gm^{-2} day)
Farmer's practice	77.3	11.5	1815	1.65	24	27.5	2985	2.15	28.0	15.12	30.2	3109	2.05	4.13
VRI 2	84.5	10.9	1840	1.66	23	29.0	3015	2.19	37.9	18.50	34.5	3565	2.10	6.97
CO 7	90.0	10.5	1885	1.69	30	38.5	3961	3.20	53.2	26.25	44.5	4250	2.90	9.63
Kadiri 9	90.2	11.0	1860	1.67	30	33.7	3745	2.95	46.1	23.20	38.2	3910	2.45	5.50
KCG 6	89.9	10.7	1845	1.67	29	32.5	3395	2.64	38.7	19.61	36.9	3620	2.35	7.50
SEd	2.3	0.51	87.4	0.07	1.03	1.55	168	0.13	2.04	1.01	1.77	177	0.11	0.33
CD (P = 0.05)	4.83	NS	NS	NS	2.18	3.30	356	0.27	4.33	2.10	3.76	377	0.24	0.69

Table 2: Chlorophyll, RWC and Proline content in groundnut leaves during water stress

Variety	Chlorophyll (mg/g fr.wt.)	Relative water content (%)	Proline (µmoles/g fr.wt.)
Farmer's practice	1.25	47.5	17.2
VRI 2	1.33	49.8	20.9
CO 7	1.91	68.5	24.3
Kadiri 9	1.81	51.5	23.6
KCG 6	1.80	53.8	21.8
SEd	0.08	2.59	1.04
CD(P = 0.05)	0.17	5.49	2.14

Table 3: Yield and yield contributing characters as influenced by groundnut genotypes

	No. Of pods/plant	Yield (kg/ha)	Haulm yield (kg/ha)	Oil content (%)	Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Income (Rs./ha)	BCR
Farmer practices	15	1330	3317	48.0	43600	59850	16250	1.37
VRI 2	16	1370	3610	49.5	42300	61650	19350	1.46
CO7	23	1990	4335	48.5	40000	89550	49550	2.24
Kadiri 9	19	1550	3780	49.0	40500	69750	29250	1.72
KCG 6	20	1880	3807	49.0	40500	84600	44100	2.09
SEd	1.1	91.2	179	2.3	--	--	--	--
CD (P = 0.05)	2.3	191.5	379	NS	--	--	--	--

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