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Evaluation of optimum sowing dates for newly developed lines of groundnut in Rainfed areas of northern Punjab

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Abstract
This study was carried out with the objective to determine the most suitable sowing time for groundnut under rainfed conditions during cropping seasons of 2013 and 2014. The trials were conducted in the field area of Groundnut Research Station Attock. The experiment was laid out according to triplicate randomized complete block design with split plot. Planting dates (20 March, 30 march, 10 April, and 20 April) were kept in main plots while cultivars (BARI-2011, 10AK020 and 10AK016) in subplots. All the fertilizers were applied at the sowing time while Gypsum was applied at peg formation stage. Crop was grown under rainfed conditions and was harvested at physiological maturity. The results showed that the most suitable planting date for genotype 10AK016 was 30th March while 10th April for BARI 2011 and 10AK020 as maximum pod yield, pod length and pod weight were recorded for this sowing time. Delay in sowing of groundnut beyond 10th April had negative effect on yield and yield attributes. So sowing of groundnut should be completed before 10th April under climatic conditions of Attock as high temperatures and drought stress occurs during peg formation and pod development and maturation periods causing significant decline in pod yield.

Keywords: *Arachis hypogaea*, drought, physiological, sowing date, pod yield, yield components

Introduction

Groundnut is one of the most important oil seed crop. It contains edible oil 50%, proteins25% and carbohydrates 10-25%. It is a rich and dietary source of vitamin E, Mg, Fe, Zn, riboflavin, Ca, phosphorus, thiamine and K. Groundnut is also used as animal diet in different forms such as straw, fodder, seeds, and hay (Awais *et al*., 2017, 2019; Nigam, 2014) [10, 11, 23]. Groundnut is sown in different Barani (rainfed) areas of Pakistan including Attock, Chakwal, Jhelum, Rawalpindi, Karak, Swabi and Sahngar on an area of 94 thousand hectares with an average production of 101 thousand tonnes and yield of 1.1 tonnes per hectare (Anonymous, 2014) [19].

Average yield of groundnut in Pakistan is very low because of early and late sowing timings, low input use by the farmer and unprecedented environmental conditions. Groundnut is basically a stifling plant and needs a lengthy and hot environment with optimum rainfall (500 mm) and optimum temperature of 25 to 30ºC (Mahmood *et al*., 2019a; Mustafa *et al*., 2018; Prasad *et al*., 2000; Qamar *et al*., 2017) [20, 22, 26, 27]. When considering economic return, the groundnut is a valuable cash crop for the barani areas of the Pothohar region. Hence, identifying yield limiting factors and appropriate agronomic management practices are crucial to increase groundnut yield potential in the barani areas. Growth and development of groundnut is greatly influenced by complex uncontrolled environmental factors. The optimum diurnal air temperature for vegetative growth and photosynthesis of groundnut is between 30 and 35 C whereas the optimum diurnal temperature for final yield and reproductive growth is little bit cooler, i.e. between 25 and 28°C (Ali *et al*., 2013, 2014, 2016; Craufurd *et al*., 2002) [12, 13, 15, 25]. High day temperatures above 35°C during the reproductive phases reduce proportion of flower forming pegs, dry matter production, number of pods per plant, harvest index, individual seed mass and pod yield (Craufurd *et al*., 2002) [31]. Long day timings (>13 h) increase crop growth rate and vegetative growth, and decrease partitioning of photosynthate to pods while Incident solar radiation and sunshine duration are also important environmental factors that affect growth and development of groundnut (Ali *et al*., 2017, 2109; Kanwal *et al*., 2019; Nigam *et al*., 1998) [12, 26, 24]. Most of the previous studies aimed to reduce drought or high-temperature stress occurring at the critical stages of groundnut growth with optimum sowing date. Studies on the effects of sowing dates and related environmental factors on growth and yield of groundnut under the rainfed conditions are very limited. The objective of the current study was to determine the most suitable sowing time for leading lines of groundnut in order to achieve maximum yield in rainfed

environment (Ahsan *et al*., 2011; Ahmad *et al*., 2012; Mahmood *et al*., 2019b; Saeed *et al*., 2012) [1, 2, 21, 29].

Materials and methods

The field trials were conducted for two years during crop growing seasons of 2013 and 2014 at Groundnut Research Station Attock. District Attock is situated at 33.7′E and 72.35′N ′N in the west Aegean region of Punjab and typical Barani climatic conditions are dominant in Pothohar region. The soils of experimental fields were sandy loam in texture, alkaline in reaction, deficient in both P and K while having adequate organic matter. The climatic conditions are given in Table 1. Generally, the total rainfall in 2013 and 2014 was lower than the long years mean (LYM) throughout peanut growth in Attock district but the mean temperature of both years was more than LYM (Table 1). Attock district had greater rainfall in 2014 than 2013. Relative humidity is suitable for groundnut growth in Attock. In particular, the relative humidity of 2013 and LYM years was normal but it increased during 2014 in Attock. The experiments were designed in split-plot design with 3 replications. Planting dates (20 March, 30 march, 10 April, and 20 April) were kept in main plots while cultivars (BARI 2011, 10AK020 and 10AK016) in subplots. Each plot consisted of 2 rows of 4 m length with inter-row spacing of 45 cm while plant to plant distance of 15 cm. All the fertilizers were applied at the sowing time while Gypsum was applied at peg formation stage. Hand weeding was done throughout the growing period when necessary. Harvesting was carried out during 1st week of December, when weather was mostly dry and cold (Table 2). All the plots were mechanically dug and inverted and allowed to air-dry in the field for 7 to 13 days before harvest. Pods were mechanically combined (referred to as combined yield), and final combined yield was adjusted to 10% moisture. A 1000-g sample of pods was removed from 3 replicates to determine shelling percentages (Williams and Drexler, 1981). The 20 pod length, 100-grain weight, maturity percentage, seed per pod, shelling percentages, pod yield per plot were determined from 10 randomly selected plants in each plot. The cultural practices used in these experiments are representative of production practices in the Pothohar region. The data was statistically analyzed by using Statistics 8.1 software program (and mean values were compared by using least significant difference (LSD) test at a level of 0.05 percent (Steel *et al*., 1997) [30].

Table 1: Monthly rain fall data of the district Attock during ten years

Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
January	86.5	45	60	00	43	38	11	05	22	165	08
February	21	160	05	200	28	53	95	42	28	82	47
March	0	113	29	145	0	52	08	48	0	182	131
April	75	40	13	26	145	73	08	16	50	47	21
May	25	25	15	39	10	26	-	03	04	10	44
June	44	1	25	101	69	03	10	41	02	67	00
July	106	226	152	88	194	76	97	178	68	127	65
August	111	198	128	121	101	106	276	91	91	155	201
September	23	130	35	54	56	41	06	71	84	0	52
October	65	14	13	00	06	07	-	34	07	22	74
November	16	4	09	27	05	04	-	04	0	20	19
December	85	0	47	00	45	0		-	78	07	00
Total	657.5	956	531	801	702	479	511	533	434	884	662

Results

Pod length

Analysis of variance for pod length showed significant differences among different genotypes and sowing dates (Table 2). Maximum pod length was observed (58 mm) was observed for groundnut sown on 10th April while minimum (50 mm) for 20th March. Genotype 10AK016 had maximum (57 mm) pod length.

Table 2: Effect of different sowing dates on pod length (mm) (data pooled over years)

Sowing dates	Genotypes			Mean
	BARI 2011	10 AK020	10AK016	
20th March	51 de	46 e	54 cd	50 d
30th March	52 d	45 e	61 a	53 c
10th April	58 b	55 c	61 a	58 a
20th April	57 bc	55 c	53 d	55 b
Mean	55 ab	50 b	57 a	54

Pod weight

There were no significant differences in respect of pod weight between different genotypes, however different sowing dates had significant effect on pod weight (Table 3). The highest pod weight was recorded for groundnut sown on 10th April followed 30th March and the least for 20th April.

Table 3: Effect of different sowing dates on pod weight (g) (data pooled over years)

Sowing dates	Genotypes			Mean
	BARI 2011	10 AK020	10AK016	
20th March	50 d	54 c	54 c	53 bc
30th March	54 c	54 c	59 b	56 b
10th April	62 a	64 a	53 cd	60 a
20th April	54 c	52 cd	47 d	51 c
Mean	55 NS	56	53	55

Maturity percentage

BARI 2011 showed highest values of maturity percentage in 2013 as compared to 2014. Among the different sowing dates, crop sown on 10-04-2013 and 10-04-2014 reached maximum maturity percentage as compared to plots sown earlier on 20-03-2013/2014 and 30-03-2013/2014.

Table 4: Effect of different sowing dates on maturity percentage (data pooled over years)

Sowing dates	Genotypes			Mean
	BARI 2011	10 AK020	10AK016	
20th March	63 c	68 bc	75 b	69 c
30th March	70 bc	75 b	84 a	76 b
10th April	83 a	79 ab	83 a	82 a
20th April	81 a	80 a	80 a	80 a
Mean	74 b	76 b	81 a	77

Number of seeds per pod

There was no significant difference in number of seeds per pod among different sowing dates. However genotypes differed significantly. Maximum number of seed per pod (2.4) was recorded in Bari 2011 and 10AK016 while number of seed per pod was minimum in 10AK020.

Table 5: Effect of different sowing dates on number of seeds per pod (data pooled over years)

Sowing dates	Genotypes			Mean
	BARI 2011	10 AK020	10AK016	
20th March	2.3 ab	2.0 b	2.3 ab	2.2 ns
30th March	2.4 a	2.0 b	2.5 a	2.3
10th April	2.4 a	2.0 b	2.3 ab	2.2
20th April	2.5 a	2.1 b	2.4 a	2.3
Mean	2.4 a	2.0 b	2.4 a	2.3

Shelling percentage

There was no significant difference in the values of shelling percentage (Table 6). Delay in sowing of groundnut beyond 30th March decreased the shelling percentage. The highest shelling percentage (52) was recorded for sowing made on 30th March. Minimum shelling percentage (48) was observed in plant sown on 20th April.

Table 6: Effect of different sowing dates on shelling percentage (data pooled over years)

Sowing dates	Genotypes			Mean
	Bari 2011	10 AK020	10AK016	
20th March	47	52	49	49 ns
30th March	48	52	57	52
10th April	57	50	47	51
20th April	47	50	46	48
Mean	50 ns	51	50	50

Pod yield

Sowing time had significant effect on pod yield wihle pod yield for different genotypes differed non-significantly (Table 7). Maximum pod yield (3.1 tons/ha) was recorded when the crop was sown on 10th April while minimum pod yield (2.4 tons/ha) was for 20th April.

Table 7: Effect of different sowing dates on pod yield (data pooled over years)

Sowing dates	Genotypes			Mean
	BARI 2011	10 AK020	10AK016	
20th March	2.7 b	2.7 b	2.9 ab	2.8 a
30th March	2.8 ab	2.6 b	3.4 a	2.9 a
10th April	3.3 a	3.1 a	2.8 ab	3.1 a
20th April	2.3 c	2.5 bc	2.3 c	2.4 b
Mean	2.8 NS	2.7	2.9	2.8

Discussion

Optimum sowing timing is an important production component that can be manipulated to counter the adverse effects of environmental stress. This is accomplished through shifting sowings so that any stress caused by environment is avoided during the critical stages of plant growth (Ali *et al*., 2010; Ntare *et al*., 1998; Banterng *et al*., 2003) [7, 25, 14]. Delay in sowing beyond 10th April resulted in significant reduction in pod yield of groundnut. These results are in agreement with the findings of Banik *et al*., (2009) [13] who observed significant reduction in pod yield of groundnut as a result of delayed sowing. Growth and development of groundnut depends on many factors however climate is the most important among them. Among climatic conditions rainfall, temperature and radiation are especially important. Legume crop are particularly sensitive to climate. In previous studies, pod yield of groundnut positively correlated with number of flowers. Delayed sowing resulted in production of less flower and ultimately reduced pod yield (Reddy and Reddy, 2001) [28]. Pod length and pod weight was maximum for plot sown on 10th April. These factors also contributed towards increase in pod yield. Bala *et al*., (2011) [12] also concluded that early sowing of groundnut resulted in maximum yield and delay in sowing resulted in significant decline in pod yield due to decrease in vegetative cycle. Most of researchers in previous studies regarding groundnut have attributed decline in yield as a result of delayed sowing to reduction in number of pods per plant (Caliskan *et al*., 2008; Canavar and Kaynak, 2008) [15]. However, contrary reports also exist. Collinson *et al*. (2000) [17] indicated that no significant difference was found between two sowing dates in Tanzania. In another report Caliskon *et al*. (2008) claimed that there was no advantage of early sowing of groundnut in respect of pod yield of groundnut.

Conclusion

Present study has led to conclusion that sowing of groundnut in rainfed should be done before 10th April for getting maximum yield. Further experimentation is required to find out the mechanism responsible for reduction in yield as a result of delayed sowing.

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