*Pak. J. Biotechnol. Vol. 20(2), 301-311, **2023*** http://doi.org/10.34016/pjbt.2023.20.02.769

Research Article

OPEN ACCESS

Available on http://www.pjbt.org
Pakistan Journal of Biotechnology
(PJBT)
(P-ISSN: 1812-1837 and E-ISSN: 2312-7791)

EVALUATING THE CAPACITY OF SUBDIVISION HYDERABAD RURAL FOR CULTIVATION OF CHICKPEA VARIETY DG-92 ON DIFFERENT FARMERS FIELDS

Abdul Hakeem Jamro[1], Aijaz Ahmed Soomro[1*], Habib-Ur-Rehman Memon[1], Irfana Parveen Bhatti[2], Ata -U-Rehman[3], Shahid Riyaz Malik[4], Abdul Naeem Shaikh[5], Israr Ahmed[6], Hadi Bux Bozdar[7]

[1]Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan.
[2]Department of Crop Physiology, Sindh Agriculture University, Tandojam.
[3]Charles Sturt University, Australia and ACIAR.
[4]National Agriculture Research Center, Islamabad, Pakistan.
[5]Quaid-E-Awam Agriculture Research Center, Larkana, Pakistan.
[6]Pulses Project, Australian Center for International Agricultural Research (ACIAR) posted at NARC, Islamabad, Pakistan.
[7]Institute of Plant Sciencess, University of Sindh, Jamshro
*Email of the Corresponding author: aijazsoomro@sau.edu.pk

Article Received 11-05-2023, Article Revised 16-08-2023, Article Accepted 10-10-2023.

ABSTRACT

This research study was carried across the field of 14 farmers of subdivision (tahseel) Hyderabad (rural), Sindh province of Pakistan during Rabi season, 2021-22 to evaluate the performance of the chickpea variety DG-92 as well as to find out the potency of a new chickpea belt in Sindh province of Pakistan. The field study was conducted in a three replicated randomized complete block design (RCBD). Different fields of fourteen (14) farmers were taken as treatments, these were (T_1 = Farmer 1, T_2= Farmer 2, T_3 = Farmer 3, T_4 = Farmer 4, T_5 = Farmer 5, T_6 = Farmer 6, T_7 = Farmer 7, T_8= Farmer 8, T_9 = Farmer 9, T_{10} = Farmer 10, T_{11} = Farmer 11, T_{12} = Farmer 12, T_{13} = Farmer 13 and T_{14}= Farmer 14) and evaluated the performance of chickpea variety DG–92 for various agronomic traits over the fields. The results showed that the highest plant population m^{-2} (32.95) was recorded at farmer 4 and the lowest (22.89) at farmer 10. The maximum plant height (77.23 cm) was recorded at farmer 1 and the minimum (48.63 cm) at farmer 8. The maximum branches $plant^{-1}$ (21.70) were recorded at farmer 1 and the minimum (7.37) at farmer 5. The maximum pods $plant^{-1}$ (75.28) were recorded at farmer 3 and the lowest (30.30) at farmer 8. The maximum seeds $plant^{-1}$ (152.37) were recorded at farmer 4 and the lowest (37.97) at farmer 8. The maximum seed weight $plant^{-1}$ (25.40 g) was observed at farmer 4 and the minimum (6.74 g) at farmer 8. The maximum seed index (310.42 g) was recorded at Farmer 5 and the minimum (216.03) at farmer 8. The maximum seed yield (1713.7 kg ha^{-1}) was observed at farmer 1 and the minimum (309,0kg ha^{-1}) at farmer 7 and the maximum biological yield (5140.9 kg ha^{-1}) was recorded at farmer 1 and the minimum (929.8 kg ha^{-1}) at farmer 7. The findings suggest that that subdivision tahseel Hyderabad rural has the great potential to cultivate Chickpea (Gram) crop to add another major Pulse crop in the cropping pattern of the area during Rabi season.

KEYWORDS: Chickpea, seed, plant height, population, biological yield

INTRODUCTION

Chickpea (*Cicer arietinum L.*) is an important pulse legume crop grown in dry and semi-arid regions around the world on mostly residual soil moisture. The chickpea most preferably originated in an area of south-eastern Turkey and adjoining Syria and domestication by humans 10,000 years ago in the old world (Abbo *et al*., 2007). Its cultivation spread through the globe about 6000 years ago, starting in south-eastern Anatolia (Sani *et al*., 2018). It is cultivated on an area of about 2.2 million hectares in Pakistan, and more than 80% chickpea area belongs to Thal. Due to increasing population and reduced yield of chickpea, Pakistan is importing chickpea (Kabuli) from Australia, Turkey and Canada. It is widely grown pulse (legume) crop in the world being cultivated in more than fifty countries with India accounting for 66.3% of global production and Pakistan (5.7%) (FAO,2019). Chickpea is classified into two distinct categories, these are Desi (small seed sized and black colored and Kabuli (bold seed sized with white color) (Kabuo *et al*., 2015; Jameel *et al*., 2021). In Pakistan, Chickpea covers 73% from whole cropped land utilized for legume productivity (Ullah *et al*., 2020). Chickpea comprises only 2.70-6.50% fat, they are a valuable source of unsaturated fats, especially linoleic and oleic acid. Main compounds found in chickpea include is of lavones and carotenoids (Chandrika *et al*.,

2021). Pakistan shares 8.2% chickpea in import of total importing from other countries. Pulses are a key source of dietary protein for millions of people in various developing countries around the world and plays a vital role in preventing protein malnutrition (Choudhary *et al*., 2018). Chickpea is a better source of carbohydrates, minerals and cheapest dietary protein (Varshney *et al*., 2019).

To cope with the increasing demand of food for increasing human population, the chickpea has capacity to be the rich food equally for all poor and rich population of the world. Because a one cup of chickpea equivalent to 164 grams (g) provides protein 14.5 grams, calories 269, fat 4 g, fiber 12.5 g, manganese 74% of daily value (DV), iron 26% of DV and zinc 23% DV. Chickpea is the biggest cool-season grain legumes after bean and field pea and it is the 2nd most cultivated legumes by poor farmers, notably in arid and semi-arid areas of Pakistan. Approximately 2.3 million tons of chickpea enter the world market annually due to increase in production per unit area (Kinfe *et al*., 2020; Rafiq *et al*.,2020). Chickpea crop is mostly grown in Pakistan's arid and semi-arid regions, and releasing chickpea varieties with reduced moisture demands are successful (Sharifi *et al*., 2018). The genetic variation among paternal genotypes provides a solid platform for scientists to identify genetic resources and cultivars that are suited (Varshney *et al*.,2019).

Chickpea cultivars are not only adapted to drought-prone parts of the world but also have been producing rich food (Rafiq *et al*., 2020). Chickpea helps the soil by fixing nitrogen through a symbiotic association with rhizobacteria. Pakistan is the 3rd in the world grower of chickpea (FAOSTAT,2015), across all regions Punjab accounts for 80% of the country's chickpea productivity (Government of Pakistan [GOP], 2016). In Pakistan, the yield of the gram crop is relatively lesser than advanced countries due to lack of improved varieties suitable for cultivation in both rain-fed and irrigated areas (Profiri *et al*., 2016).Varietal agronomic studies are important for estimating yield performance of the different varieties and agronomic forms of treatment across environments and studying of chickpeas growers both nation leading role and great cultivars of the this crop are also required (Profiri *et al*., 2016). Performance of chickpea varies for yield and other agronomic parameters (Khana *et al*., 2015; Dahleen *et al*., 2018). The assessment of elite chickpea cultivars and progressed lines is critical for chickpea development (Porfiri *et al*., 2016). Keeping in view the importance and scope of the study on chickpea for increasing its area and production, this study has been carried out ever first time in the subdivision (tahseel) Hyderabad (rural) to achieve two main objectives, these were to evaluate the growth and yield of chickpea variety DG-92 in this targeted area and to categorize the fields of the involved farmers as per growth and yield traits of chickpea variety DG-92.

MATERIALS AND METHODS

The study was carried out at different 14 farmers fields of subdivision/tahseel Hyderabad (rural) during the Rabi season, 2021-22. Randomized complete block design was used with three replications. All the agronomic requirements from land preparation to harvesting were provided to the crop following standard methods.

The sugar solution was prepared @ 250 g of sugar and 750 g of water = 01 kg solution. The solution was sprayed over the 60 kg chickpea seed for one acre to make it sticky as biozote rhizobium bacteria and thiomil (anti pathogen) could stuck with chickpea seed properly. A pack of biozote at the rate of 400 g per acre was uniformly mixed with the chickpea seeds as all grains/seeds contain the biozote. Then one pack of Thiomil @ 400 g per acre (anti pathogen) was also mixed with the chickpea seeds similar to biozot. Then, the seeds were sown through hand drills in already well-prepared land. The weeds were controlled with Dual Gold (pre-emergence) herbicide which was applied before seed sowing at the rate of one bottle of 800 ml per acre.

Randomized complete block design (RBCD) with 03 replication was used. The net plot size per replication was 5m x $3m^2$ ($15m^{-2}$). Chickpea variety 'DG-92' was used. The farmers (in total 14) were considered as treatment and coded as **i.** Farmer 1, **ii**. Farmer 2, (Inter cropped chickpea with mango), **iii.** Farmer 3, **iv.** Farmer 4, **v.** Farmer 5, **vi.** Farmer 6, **vii.** Farmer 7, **viii**. Farmer 8, **ix.** Farmer 9, **x.** Farmer 10, **xi.** Farmer 11, **xii.** Farmer 12, **xiii.** Farmer 13, **xiv.** Farmer 14.

Data Collection: Minimum 50 plants per replication were sampled. Thus, 150 plants were sampled from the field of each farmer and the data of the Plant population (m^2): Plant height (cm): Branches $plant^{-1}$ Pods $plant^{-1}$ Seeds $plant^{-1}$ Seed weight $plant^{1}$(g): Seed index (g); Seed yield (kg ha^{1}): Biological yield (kg ha^{1}) were recorded.

Data Analysis: The collected data were subjected to differences among the treatments and the same were compared by the least significant difference (LSD) @ 0.5% probability, where necessary. ANOVA was calculated using Statistix (2006).

Results

Plant population (m^2): The results regarding mean plant population m^2 of Chickpea variety DG-92 as investigated at different farmer's field in targeted area and their outcomes are presented in Table 1. The analysis of variance proved that the chickpea variety at different farmers' fields affected significantly at ($p<0.05$) (Table 2). Results showed in the (Table 1) revealed that the maximum plant population m^2 (32.95) was recorded from the field of (farmer 4) and minimum plant

population m^2 (22.89) was recorded from the field of (Farmer 10).

Table 1 Plant population (m^{-2}) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	32.19 ab	0.2403
T_2 = Farmer 2	29.36 c	0.3205
T_3 = Farmer 3	30.07 bc	1.2463
T_4 = Farmer 4	32.95 a	0.9109
T_5 = Farmer 5	29.34 c	0.4224
T_6 = Farmer 6	28.96 c	0.5558
T_7 = Farmer 7	28.80 c	0.3963
T_8 = Farmer 8	25.84 d	0.9353
T_9 = Farmer 9	25.29 d	1.1385
T_{10} = Farmer 10	22.89 e	1.1893
T_{11} = Farmer 11	25.72 d	0.8493
T_{12} = Farmer 12	25.99 d	1.8544

Table 2 Analysis of variance for Plant population (m^{-2})

Source	DF	SS	MS	F	P
Replication	2	6.871	3.4357	-	-
Treatments	9	259.436	28.8262	15.37	0.0000
Error	18	1.8760	33.767	-	-
Total	29	300.075	-	-	-
CV= 4.79 %					

Plant height: The varietal impact or response of chickpea crop to different management factors is primarily revealed by the plant height. The results regarding mean plant height (cm) of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 3 and the analyses of variance as Table 4. The analyses of variance proved that the chickpea variety at different farmers' fields were affect significant at ($p<0.05$). Results showed in the Table 3 revealed that the maximum plant height (77.23 cm) was recorded from the field of (Farmer 1) and the minimum plant height (48.63 cm) was recorded from the field of (Farmer 8).

Branches per plant: The branches $plant^{-1}$ is one of the most important factor for chickpea plant that has direct impact on grain yield of chickpea, because more branches $plant^{-1}$ produce more pods and seeds and hence it has a positive effect on yield of chickpea. The results regarding mean branches $plant^{-1}$ of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in (Table 5) and the analyses of variance as Table 6. The analyses of variance proved that the chickpea variety at different farmers' fields were effect significant at ($p<0.05$). Results showed in the (Table 5) revealed that the maximum branches $plant^{-1}$ (21.70) were recorded from the field of (Farmer 1) and minimum branches $plant^{-1}$ (7.37) were recorded from the field of (Farmer 5).

Pods per plant: The pods $plant^{-1}$ is one of the most important factor for chickpea plant that has direct impact on grain yield of chickpea, because more pods $plant^{-1}$ produce more seeds and hence it has a positive effect on yield of chickpea. The results regarding mean pods $plant^{-1}$ of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 7 and the analyses of variance as Table 8. The analyses of variance proved that the chickpea variety at different farmers' fields were effect significant at ($p<0.05$). Results showed in the (Table 7) revealed that the maximum pods $plant^{-1}$ (75.28) were recorded from the field of (Farmer 3) and minimum pods $plant^{-1}$ (30.30) were recorded from the field of (Farmer 8).

Table 3 Plant height (cm) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	77.23a	2.5976
T_2 = Farmer 2	77.00a	2.3030
T_3 = Farmer 3	60.77cd	2.1372
T_4 = Farmer 4	68.53b	1.5953
T_5 = Farmer 5	51.70ef	2.3924
T_6 = Farmer 6	65.57bc	1.1893
T_7 = Farmer 7	52.00ef	2.9143
T_8 = Farmer 8	48.63f	3.4119
T_9 = Farmer 9	52.73ef	1.1325
T_{10} = Farmer 10	55.40de	1.1732
T_{11} = Farmer 11	52.87ef	2.8521
T_{12} = Farmer 12	53.94de	1.8452

Table 4 Analysis of variance for Plant height (cm)

Source	DF	SS	MS	F	P
Replication	2	64.21	32.104	-	-
Treatments	9	3100.01	344.446	31.11	0.0000
Error	18	199.31	11.073	-	-
Total	29	3363.53	-	-	-
CV= 5.45 %					

Seeds per plant: The seeds plant^{-1} is one of the crucial factor for chickpea plant that has direct impact on grain yield of chickpea, because more seeds plant^{-1} produce more yield and hence it has a positive effect on yield of the chickpea. The results regarding mean seeds plant^{-1} of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 9 and the analyses of variance as Table 10. The analyses of variance proved that the chickpea variety at different farmers' fields were effect significant at ($p<0.05$). Results showed in the (Table 9) revealed that the maximum seeds plant^{-1} (152.37) were recorded from the field of (Farmer 4) and minimum seeds plant^{-1} (37.97) were recorded from the field of (Farmer 8).

Seeds weight plant^{-1}: The seeds weight plant^{-1} is also one of the most important factor for chickpea plant and has a direct impact on grain yield of chickpea, because high seeds weight plant^{-1} indicates maximum seed yield and hence it has a positive effect on yield of chickpea. The results regarding mean seeds weight plant^{-1} (g) of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 11 and the analyses of variance as Table 12. The analyses of variance proved that the chickpea variety at different farmers' fields were effect significant at ($p<0.05$). Results showed in the (Table 11) revealed that the maximum seeds weight plant^{-1} (25.40 g) was recorded from the field of (Farmer 4) and minimum seeds weight plant^{-1} (6.74 g) was recorded from the field of (Farmer 8).

Seed index (1000-Grains weight g): The seed index also has significant effect on chickpea yield because higher the seeds weight greater the yield hence it has positive impact on yield of chickpea. The result regarding mean seed index (1000-grain weight, g) of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 13. The analyses of variance (Table 14) proved that the chickpea variety at different farmers' fields were affect significant at ($p<0.05$). Results showed in the (Table 13) revealed that the maximum seed index (310.42 g) was recorded from the field of (Farmer 5) and minimum seed index (216.03 g) was recorded from the field of (Farmer 8).

Seed yield (kg ha^{-1}): The seed yield (kg ha^{-1}) also has significant role on chickpea yield it has direct impact on the grain yield of chickpea plant because high quality seeds weight greater the yield hence it has positive impact on the yield of chickpea crop. The result regarding mean seed yield (kg ha^{-1}) of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 15 and the analyses of variance as Table 16. The analyses of variance proved that the chickpea variety DG-92 at different farmers' fields were effect significant at ($p<0.05$). Results showed in the (Table 15) revealed that the maximum seed yield (1713.7 kg ha^{-1}) was recorded from the field of (Farmer 1) and minimum seed yield (309.0 kg ha^{-1}) was recorded from the field of (Farmer 7).

Table 5 Branches plant^{-1} of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	21.70a	0.5429
T_2 = Farmer 2	20.61a	0.3265
T_3 = Farmer 3	14.20c	1.3462
T_4 = Farmer 4	14.90b	0.7632
T_5 = Farmer 5	7.37f	0.5428
T_6 = Farmer 6	7.87ef	0.4721
T_7 = Farmer 7	7.90ef	0.5723
T_8 = Farmer 8	7.70ef	1.3472
T_9 = Farmer 9	10.37de	1.5628
T_{10} = Farmer 10	11.47cd	1.0523
T_{11} = Farmer 11	11.40cd	1.5673
T_{12} = Farmer 12	10.10d	0.8505

Table 6 Analysis of variance for Branches plant^{-1}

Source	DF	SS	MS	F	P
Replication	2	23.651	11.8253	-	-
Treatments	9	772.641	85.8490	30.97	0.0000
Error	18	49.903	2.7724	-	-
Total	29	846.195	-	-	-
CV= 13.41 %					

Biological yield (kg ha^{-1}): The biological yield (kg ha^{-1}) is practiced by weighting total crop biomass including leaves, stem, straw including grains. The biological yield may differ from field to field due to environmental factors. The **results** regarding mean biological yield (kg ha^{-1}) of chickpea variety DG-92 as affected at different farmers' fields in Tandojam surroundings and are presented in Table 17 and the analyses of variance as Table 18. The analyses of variance proved that the chickpea variety DG-92 at different farmers' fields were affect significant at ($p<0.05$). Results showed in the (Table 17) revealed that the maximum biological yield (5140.9 kg ha^{-1}) was recorded from the field of (Farmer 1) and minimum biological yield (929.8 kg ha^{-1}) was recorded from the field of (Farmer 7).

DISCUSSION

Performance of chickpea variety DG-92 was evaluated at different farmers' fields of Tandojam surroundings (subdivision Hyderabad rural) for which different agronomic observations evaluated, such as plant population (m^{-2}), plant height (cm), branches plant^{-1}, pods plant^{-1}, seeds plant^{-1}, seeds weight plant^{-1} (g), seed index (g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}). The mean highest grain yield of chickpea variety DG-92 was obtained (1713.66 kg ha^{-1}) from field of (Farmer 1) as compared to other farmers' fields, because (Farmer 1) sown chickpea on 1st November and obtained maximum yield. In case of other farmers fields they faced many of problems, such as unavailability of suitable soil, unavailability of canal water, unavailability of educated working staff and some other factors for cultivation of chickpea crop. Because they cultivated this crop ever first time and they had no experience of sowing this crop. This evaluation of chickpea variety DG-92 on different fields of Tandojam (Hyderabad subdivision rural) helped the farmers to understand different responses of chickpea at different farmers' field.

Results showed that chickpea might be sown sole in the field instead of intercrop and also this crop may not be grown in the area where trees are cultivated because shade of the trees affected the plant height and number of branches per plant. Shade also invited the pests like pod borer and reduces the seed yield of the crop. Chickpea crop must be sown from 1st November to 2nd week of November later than that period temperature reduces and crop suffers from lower temperature and reduces the height of plants. The responses of chickpea to different farmers' fields revealed considerable differences in early development stage characteristics and grain yield. The significance of the variants represented the varying reactions of the DG-92 variety to various locations at different growth stages. These changes might be due to variances in the analyzed variety's genetic composition. Different studies have also reported on how chickpea types respond differently at different locations and at different stages

of maturity (Ahmed *et al*., 2009; Maqbool *et al*., 2015; Maqbool *et al*., 2016).

Different chickpea parameters viz pods plant^{-1}, seeds plant^{-1}, branches plant^{-1}, seed index and seed yield were recorded for variety DG-92 planted at various sites over a wide temperature range. According to the literature, crop development requires evaluation and screening of variety DG-92 on farmers' fields under drought stress using physiological and biochemical markers Talebi *et al*. (2013). Variety responses at early growth stages have also been observed to be diversified under different field circumstances. Misra & Dwivedi (2004), indicated that continuous chickpea assessment is required for the creation of novel high yielding stress resistant cultivars. As a result the physio-chemical characteristics and yield performance of the chickpea variety were assessed further.

Chickpea showed a similar sensitivity to phenological alterations. Warmer temperatures of the evaluated area Hyderabad @ Tandojam in month of April due to warmer winds at the time of the harvesting showed adverse effects on crop development and reduce the growth as well as grain yield are in similarity with that of previous research studies of Sadras & Monzon (2006); Tao *et al*. (2006); Challinor & Wheeler (2008). Climate change lowered the number of days to maturity for rain-fed chickpea according to a simulation research on the crop Koecheki *et al*. (2006). The increase in temperature might have caused moisture stress in the plants resulting in a decrease in stomata conductance. According to Khetrapal *et al*. (2009), the stomata conductance of the chickpea crop reduced considerably at all development stages when the temperature was raised. The results of high temperature stress during chickpea reproductive development revealed that seed yield reduced due to a decrease in the number of seeds per plant and seeds weight per seed as well as a decrease in the crop's harvest index (Wang *et al*., 2006).

In this study, there was a lot of variation for yield and other agronomic traits of chick pea variety 'DG92'. A variety of physiological and biochemical properties of chickpeas have been described by a number of other studies (Ali *et al*., 2011; Ceyhan *et al*., 2012). This type might be classified as drought resistant due to its good production under a variety of harsh climatic conditions. However, because of lower growth performance at the germination and seedling phases this variety was not shown to be drought resistant at early growth stages at this area of study. These findings revealed that improved performance of chickpea cultivars at early development stages does not ensure high yield or drought resistance at later stages. It has been suggested that higher seedling growth performance under drought stress may lead to an earlier reproductive maturity which may result in a yield penalty (Maqbool *et al*., 2015; Maqbool *et al*., 2016).

.

Plant height and pods plant^{-1} all negatively affected in inter-cropped plots of different farmers and chickpea cultivars. Other researchers had noted the diversity in planting dates and chickpea types for yield and yield components, days to flowering and maturity. Furthermore, the availability of appropriate temperature and moisture regimes as well as a longer growing period resulted in larger numbers of days taken to 50% flowering and 90% maturity in early seeded crops according to Ozdemir & Karadavut (2004). After a delay in seedling emergence due to low temperatures on the 15th of December while seeded crops on the 15th of November swiftly developed a greater crop cover and grain yield in favorable temperatures, soil moisture availability and longer growth duration (Ozdemir & Karadavut, 2004). However, a delay in planting resulted in a negative impact on the climate resulting in low crop stand and a short time for them to complete their life cycle, particularly after November 15th (O'Toole *et al*., 2001). The reduced number of 1000-seeds weight and seed yield in late autumn sowing dates was related to flowering and pod formation stages being exposed to hot and low temperatures Chaitanya & Chandrika (2006). Our observations in terms of shorter growing season directly related with the change temperature are also directly similar to other studies. For this, the findings revealed that cooler temperature which occurs during the early stages of vegetative growth might be damaging for late autumn seeded. Early spring sowing typically give crop ability to avoid frost risk. In the production stages of the crop development autumn sown chickpea may encounter water limitations. We discovered that the increased yield on November 15th was linked to good environmental circumstances which might be lost if unfavorable ones prevailed (Oweis *et al*., 2004).

CONCLUSIONS

From the present results it could be concluded that chickpea crop grown on the fields of 14 different farmers, from which grown well and best at the field of (Farmer 1) for all agronomic traits including grain yield (kg ha^{-1}). The crop management practices of the (farmer 1) were comparatively better than other chickpea farmers. Therefore, he harvested higher yield than others. In case of inter-cropping with mango, the plant population per acre was obviously lower than the fields where crop was cultivated as a single crop. The area under the umbrella /canopy of the mango trees was very thinly populated with the plants of the chickpea due to shade of the mango trees, only few plants were noted under each mango tree. Therefore, the yield was also lesser than the crop cultivated as a single/sole crop. Hence, it is better for the farming families of this area to cultivate the chickpea alone rather than inter corpped with any other crop or orchard

Table 7. Pods plant^{-1} of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	**Mean**	**S.E ±**
T_1 = Farmer 1	71.74 ab	2.1698
T_2 = Farmer 2	64.94b	1.8863
T_3 = Farmer 3	75.28 a	3.4104
T_4 = Farmer 4	66.47 ab	3.0910
T_5 = Farmer 5	42.00 cd	1.9630
T_6 = Farmer 6	46.93 c	4.4296
T_7 = Farmer 7	39.70 cde	1.7349
T_8 = Farmer 8	30.30 e	1.5716
T_9 = Farmer 9	37.47 cde	3.0953
T_{10} = Farmer 10	35.90 de	6.2389
T_{11} = Farmer 11	42.90 cd	2.5120
T_{12} = Farmer 12	43.60 cd	8.3032

Table 8 Analysis of variance for Pods plant^{-1}

Source	**DF**	**SS**	MS	**F**	**P**
Replication	2	30.63	15.315	-	-
Treatments	9	7552.86	839.206	24.73	0.0000
Error	18	610.83	33.935	-	-
Total	29	8194.32	-	-	-
CV= 11.41 %					

Table 9 Seeds plant^{-1} of chickpea variety DG-92 as affected at different farmers' fields of Hyderabad subdivision (Rural)

Treatments	**Mean**	**S.E ±**
T_1 = Farmer 1	129.10b	3.1362
T_2 = Farmer 2	118.90c	2.3520
T_3 = Farmer 3	131.80b	1.5237
T_4 = Farmer 4	152.37a	1.7832
T_5 = Farmer 5	70.73de	2.4362
T_6 = Farmer 6	77.30d	3.0926
T_7 = Farmer 7	69.53de	2.7830
T_8 = Farmer 8	37.97g	2.4537
T_9 = Farmer 9	64.23e	4.7628
T_{10} = Farmer 10	53.07f	9.1573
T_{11} = Farmer 11	74.93de	11.4528
T_{12} = Farmer 12	73.66de	7.4629

Table 10 Analysis of variance for Seeds plant^{-1}

Source	**DF**	**SS**	MS	**F**	**P**
Replication	2	41.3	20.64	-	-
Treatments	9	41055.6	4561.73	73.11	0.0000
Error	18	1123.1	62.39	-	-
Total	29	42220.0	-	-	-

Table 11 Seeds weight plant^{-1} (g) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	21.52b	0.4508
T_2 = Farmer 2	19.82b	0.5392
T_3 = Farmer 3	21.96b	0.0643
T_4 = Farmer 4	25. 40a	0.5382
T_5 = Farmer 5	11.91c	0.6732
T_6 = Farmer 6	13.07c	0.6732
T_7 = Farmer 7	12.32c	0.4782
T_8 = Farmer 8	6.74d	0.4872
T_9 = Farmer 9	11.42 c	1.3673
T_{10} = Farmer 10	10.99 c	2.7843
T_{11} = Farmer 11	15.63b	2.3343
T_{12} = Farmer 12	17.12b	1.4339

Table 12 Analysis of variance for Seeds weight plant^{-1} (g)

Source	DF	SS	MS	F	P
Replication	2	2.20	1.101	-	-
Treatments	9	1011.30	112.367	48.17	0.0000
Error	18	41.99	2.333	-	-
Total	29	1055.49	-	-	-
CV= 9.84 %					

Table 13. Seed index (1000-seeds weight, g) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	284.97bcd	5.6734
T_2 = Farmer 2	302.60ab	3.7620
T_3 = Farmer 3	294.37abc	4.9870
T_4 = Farmer 4	301.59ab	3.6527
T_5 = Farmer 5	310.42a	5.0983
T_6 = Farmer 6	292.77abc	3.6642
T_7 = Farmer 7	289.22abcd	3.5428
T_8 = Farmer 8	216.03e	4.5427
T_9 = Farmer 9	268.09d	5.1234
T_{10} = Farmer 10	276.11cd	2.1193
T_{11} = Farmer 11	272.55cd	3.1283
T_{12} = Farmer 12	282.27bcd	2.7520

Table 14 Analysis of variance for Seed index (1000-seeds weight, g)

Source	DF	SS	MS	F	P
Replication	2	58.0	28.98	-	-
Treatments	9	19498.8	2166.53	13.39	0.0000
Error	18	2913.5	161.86	-	-
Total	29	22470.2	-	-	-
CV= 4.49 %					

Table 15 Seed yield (kg ha^{-1}) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	1713.7A	115.16
T_2 = Farmer 2	1434.0B	86.438
T_3 = Farmer 3	1212.2C	69.065
T_4 = Farmer 4	1312.3BC	69.147
T_5 = Farmer 5	850.9D	.59.788
T_6 = Farmer 6	844.3D	78.890
T_7 = Farmer 7	309.0F	21.237
T_8 = Farmer 8	334.0F	30.532
T_9 = Farmer 9	503.4E	44.443
T_{10} = Farmer 10	585.5E	37.420
T_{11} = Farmer 11	432.2	52.407
T_{12} = Farmer 12	628.11	26.835

Table 16. Analysis of variance for Seed yield (kg ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	138331	69165	-	-
Treatments	9	6434979	714998	98.46	0.0000
Error	18	130712	7262	-	-
Total	29	6704022	-	-	-

Table 17 Biological yield (kg ha^{-1}) of chickpea variety DG-92 as affected at different farmers' fields of Tandojam surroundings.

Treatments	Mean	S.E ±
T_1 = Farmer 1	5140.9a	345.45
T_2 = Farmer 2	4300.9b	259.73
T_3 = Farmer 3	3636.8c	207.14
T_4 = Farmer 4	3938.0bc	206.98
T_5 = Farmer 5	2552.4d	179.54
T_6 = Farmer 6	2532.8d	236.87
T_7 = Farmer 7	929.8f	61.360
T_8 = Farmer 8	1001.2f	91.879
T_9 = Farmer 9	1245.1ef	252.08
T_{10} = Farmer 10	1693.1e	151.50
T_{11} = Farmer 11	2740.3cd	240.94
T_{12} = Farmer 12	1513.5e	158.87

Table 18 Analysis of variance for biological yield (kg ha^{-1})

Source	DF	SS	MS	F	P
Replication	2	1495294	747647	-	-
Treatments	9	6.039E+07	6710473	95.69	0.0000
Error	18	1262254	70125	-	-
Total	29	6.315E+07	-	-	-
CV= 9.82 %					

ACKNOWLEDGEMENT

The authors are highly grateful to the Australian Center for International Agricultural Research (ACIAR) for full sponsorship to this project.

REFERENCES

Abbo, S., Redden, R. J., Yadav, S. S., Chen, W. & Sharma, B. (2007). Utilization of wild relatives. *Chickpea Breeding and Management. CAB International, Wallingford, UK*, **3**(5), 338-368.

Ahmad, S., Ahmad, R., Ashraf, M. Y., Ashraf, M. & Waraich, E. A. (2009). Sunflower (*Helianthus annuus* L.) response to drought stress at germination and seedling growth stages. *Pakistan Journal of Botany*, **41**(2), 647-654.

Ali, M. A., Jabran, K., Awan, S. I., Abbas, A., Zulkiffal, M., Acet, T. & Rehman, A. (2011). Morpho-physiological diversity and its implications for improving drought tolerance in grain sorghum at different growth stages. *Australian Journal of Crop Science*, **5(**3), 311-320.

Atienza, S. G. & Rubiales, D. (2017). Legumes in sustainable agriculture. *Crop and Pasture Science*, **68**(11), 1-6.

Ceyhan, E., Kahraman, A., Önder, M., Ateş, M. K., Karadaş, S., Topak, R. & Avcı, M. A. (2012). Physiological and biochemical responses to drought stress of chickpea genotypes. *International Journal of Agricultural and Biosystems Engineering*, **6**(6), 352-357.

Chaitanya, S. K. & Chandrika, V. (2006). Performance of chickpea varieties under varied dates of sowing in Chittoor district of Andhra Pradesh. *Legume Research-An International Journal*, **29**(2), 137-139.

Challinor, A. J. & Wheeler, T. R. (2008). Crop yield reduction in the tropics under climate change: processes and uncertainties. *Agricultural and Forest Meteorology*, **148**(3), 343-356.

Chandrika, A., Faiz, S., Shah, J., Ramzan, A., Ihsan, M. & Saleem, M. (2021). Technological, processing and nutritional aspects of chickpea (*Cicer arietinum* L.). *Saudi Journal of Pathology and Microbiology*, **6I**(5), 150-155.

Choudhary, A. K., Sultana, R., Vales, M. I., Saxena, K. B., Kumar, R. R. & Ratnakumar, P. (2018). Integrated physiological and molecular approaches to improvement of abiotic stress tolerance in two pulse crops of the semi-arid tropics. *The Crop Journal*, **6**(2), 99-114.

Dahleen, L.S., Okubara, P.A. & Blechl, A.E. (2018). Transgenic approaches to combat Fusarium Head Blight in chickpea. *Journal of Crop Science*, **41**(4), 628-637.

Dixit, G. P., Srivastava, A. K. & Singh, N. P. (2019). Marching towards self-sufficiency in chickpea. *Current Science*, **116(**2), 239-242.

FAO, F. (2019). United Nation's Food and Agricultural Organization

FAOSTAT (2015). Food and Agriculture data FAOSTAT provides free access to Food and Agriculture data for over 245 Countries and territories and covers all FAO Regional Groupings from 1961 to the most recent year available.

Government of Pakistan [GOP] (2016). Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock, Govt of Pakistan. Food and Agriculture Division (Planning unit) Islamabad. Government of Pakistan.

Jameel, S., Hameed, A. & Shah, T. M. (2021). Biochemical profiling for antioxidant and therapeutic potential of Pakistani Chickpea (*Cicer arietinum* L.) genetic resource. *Frontiers in Plant Science*, **12**(3), 574-582.

Kabuo, N. O., Dialoke, S. A., Omeire, G. C. & Bedi, E. N. (2015). Comparison of proximate composition of some cultivars of chickpea (*Cicer arietinum* L.) cultivated in Owerri, Imo State, Nigeria. *Food Science and Quality Management*, **37**(5), 103-109.

Khanna, R., Chopra, C. & Viswanathan, C. (2015). Evaluation of heat stress tolerance in irrigated environment of wheat (*Triticum aestivum* L.) and related species. *Journal of Crop Science*, **10**(3), 169-180.

Khetrapal, S., Pal, M. A. D. A. N. & Lata, S. N. E. H. (2009). Effect of elevated temperature on growth and physiological characteristics in chickpea cultivars. *Indian Journal of Plant Physiology*, **14**(4), 377-383.

Kinfe, E., Singh, P. & Fekadu, T. (2015). Physicochemical and functional characteristics of Desi and Kabuli chickpea (*Cicer arietinum* L.) cultivars grown in Bodity, Ethiopia and sensory evaluation of boiled and roasted products prepared using chickpea varieties. *International Journal of Current Research Bioscience and Plant Biology*, **2**(3), 21-29.

Koocheki, A., Nassiri, M., Soltani, A., Sharifi, H. & Ghorbani, R. (2006). Effects of climate change on growth criteria and yield of sunflower and chickpea crops in Iran. *Climate Research, 30*(3), 247-253.

Mahmood, M. T., Ahmad, M., Ali, I., Hussain, M., Latif, A. & Zubair, M. (2018). Evaluation of chickpea genotypes for genetic diversity through multivariate analysis. *Journal of Environmental and Agricultural Sciences, 15*(6), 11-17.

Maqbool, M. A., Aslam, M., Ali, H. & Shah, T. M. (2016). Evaluation of advanced chickpea (*Cicer*

arietinum L.) accessions based on drought tolerance indices and SSR markers against different water treatments. *Pakistan Journal of Botany*, *48*(4), 1421-1429.

Maqbool, M. A., Aslam, M., Ali, H., Shah, T. M., Farid, B. & Zaman, Q. U. (2015). Drought tolerance indices based evaluation of chickpea advanced lines under different water treatments. *Research on Crops*, **16**(2), 336-344.

Misra, N., & Dwivedi, U. N. (2004). Genotypic difference in salinity tolerance of green gram cultivars. *Plant Science*, **166**(5), 1135-1142.

O'Toole, N., Stoddard, F. L. & O'Brien, L. (2001). Screening of chickpeas for adaptation to autumn sowing. *Journal of Agronomy and Crop Science*, **186**(3), 193-207.

Oweis, T., Hachum, A. & Pala, M. (2004). Water use efficiency of winter-sown chickpea under supplemental irrigation in a Mediterranean environment. *Agricultural Water Management*, **66**(2), 163-179.

Sani, S. G. A. S., Chang, P. L., Zubair, A., Carrasquilla-Garcia, N., Cordeiro, M., Penmetsa, R.V. & von-Wettberg, E.J. (2018). Genetic diversity, population structure, and genetic correlation with climatic variation in chickpea (*Cicer arietinum* L.) landraces from Pakistan. *The Plant Genome*, **11**(1), 1-10.

Sharifi, P., Astereki, H. & Pouresmael, M. (2018). Evaluation of variations in chickpea (*Cicer arietinum* L.) yield and yield components by multivariate technique. *Annals of Agrarian Science*, **16**(2), 136-142.

Talebi, R., Ensafi, M. H., Baghebani, N., Karami, E. & Mohammadi, K. (2013). Physiological response of chickpea (*Cicer arietinum* L.) genotypes to drought stress. *Environmental and Experimental Biology* **11**(3), 9-15.

Tao, F., Yokozawa, M., Xu, Y., Hayashi, Y. & Zhang, Z. (2006). Climate changes and trends in phenology and yields of field crops in China. *Agricultural and Forest Meteorology*, **138**(1-4), 82-92.

Özdemir, S. & Karadavut, U. (2004). Comparison of the performance of autumn and spring sowing of chickpeas in a temperate region. *Turkish Journal of Agriculture and Forestry*, **27**(6), 345-352.

Porfiri, M.J., Luth, D., Blankenship, K.M. & Anderson, A.D. (2016). Activity of a maize ubiquitin promoter in transgenic rice. *Journal of Plant Biology*, **23**(2), 567-81.

Rafiq, M., Mahmood, M. T., Ahmad, M., Ali, I., Saleem, M., Rasool, I. & Ali, Z. (2020). Differential response of elite chickpea genotypes under moisture stress conditions. *Pakistan Journal of Agriculture and Research*, **33**(6), 422-428.

Sadras, V. O. & Monzon, J. P. (2006). Modelled wheat phenology captures rising temperature trends: Shortened time to flowering and maturity in Australia and Argentina. *Field Crops Research*, **99**(2-3), 136-146.

Ullah, A., Shah, T. M. & Farooq, M. (2020). Pulses production in Pakistan: status, constraint and opportunities. *International Journal of Plant Production*, **14**(4), 549-569.

Varshney, R. K., Thudi, M. & Muehlbauer, F. J. (2017). The chickpea genome: An introduction. In *The Chickpea Genome* **22**(1-4), 260-271.

Varshney, R. K., Thudi, M., Roorkiwal, M., He, W., Upadhyaya, H. D., Yang, W. & Liu, X. (2019). Resequencing of 429 chickpea accessions from 45 countries provides insights into genome diversity, domestication, and agronomic traits. *Nature Genetics*, **51**(5), 857-864.

Wang, J., Gan, Y. T., Clarke, F. & McDonald, C. L. (2006). Response of chickpea yield to high temperature stress during reproductive development. *Crop Science*, **46**(5), 2171-2178