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Effect of Seeds Size on Yield and Yield Components of Chickpea (*Cicer arietinum*)

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Abstract: The study was carried out during the chickpea growing season to study the effect of seed size on yield and yield components of chickpea. Ten chickpea genotypes NKC-5-S13, NKC-5-S24, NKC-5-S17, NDC-122, NDC-4-20-6, NKC-5-S16, KARAK-2, NDC-4-20-1, NIFA-88 and NIFA-95 were used in this study. Randomized complete design (RCBD) was used with three replications. Data were recorded on days to 50% flowering, plant height, primary branches plant^{-1}, secondary branches plant^{-1}, pods plant^{-1}, seeds pod^{-1}, number of seeds plant^{-1}, 100 seed weight, biological yield plant^{-1}, harvest index, leaf area, leaflet leaf^{-1}, seed yield plant^{-1}, seed yield plot^{-1}. Significant differences were observed for all traits. Ranges of different parameters were recorded as 138-149.3 for days 50% flowering, 53.3-67.8cm for plant height, 1.6-4.5 for primary branches plant^{-1}, 4.1-9.7 secondary branches plant^{-1}, 25-69.2 for pods plant^{-1}, 1-1.7 for number of seeds pod^{-1}, 34.8-69.5 for number of seed plant^{-1}, 18.4-31.1g for 100-seed weight, 9.9-40.5g for biological yield plant^{-1}, 29-51.1g for harvest index, 290.1-716g seed yield plot^{-1}, 4.5-20.5g for seed yield plant^{-1}, 3.8-8cm for leaf area and 12-14.9 for number of leaflets leaf^{-1}.The effect of seed size on yield and yield components was significant for most of the traits.

Key words: *Cicer arietinum*,Seed size, Yield components

Introduction

Chickpea (*Cicer arietinum* L.) is a cool season annual crop that belongs to the family leguminsae and sub family Papilionacae. It is commonly known as gram or Channa. Chickpea is grown in wide range of environment comprising about 44 countries tropical, subtropical and temperate regions of the world (Muehlbauer and Tallu, 1997; Singh and Saxena, 1999). Chickpea is classified into two types called Desi and Kabuli. The small angular and colouredseeds are classified as Desi and the

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large ram head shaped and light coloured seeds are classified as Kabuli (Oplinger et al., 1990; Singh and Saxena, 1999).

Chickpea is a rich and cheapest source of nutritive elements, containing 17-31% protein in seeds, 64% total carbohydrates, 5% fat, 6% crude fiber and 3% ash. It is an important crop for both human and animal feed. Pakistan is a protein deficient country and major protein requirement are meet through pulses (Satter et al., 1990).

Chickpea is generally considered to be a hardy crop which adapts well to a wide range of soil and environmental condition and requires few inputs. In Pakistan Desi type chickpea is grown on large scale because its production and utilization is more. It can be grown on the soil which is not suitable for a crop like wheat. It grows well in clayey soil or sandy soil. In dry farming systems of sandy zones gram is a source of income for the farmers and also provide livestock feed (Satter et al., 1990).

In order to reduce yield losses in spring planting, seeds should be sown as early as possible but sowing is delayed to escape anthracnose epidermis and unfavorable early planting conditions. Seeds should be sown 5-7 cm deep using a drill or planter which can deliver seed without damage. Good seed soil contact should be ensured with a press wheel if possible (Smithson et al., 1985). Chickpea is predominantly consumed as a pulse both in dried and green form. Seeds flour can be used as soup, dhal and to make bread, prepared with pepper, salt and lemon. It served as a side dish. Chickpea yield 21% starch suitable for textile sizing, giving a light finish to silk, wool and cotton (Duke, 1981). Several biotic and abiotic factors cause low yield in chickpea.

Grain yield in many crops is a complex character and is final product of many contributing traits and their interactions. Seed size significantly affected seed yield and yield components of chickpea. Seed size as determined by seed weight, is an important trait for trade and component of yield and adaptation in chickpea (*Cicer arietinum* L.) (Upadhyaya et al., 2006). Appearance of chickpea seed is a key market factor and acceptability varies with cultural preference. In particular, larger seed size coupled with other desirable traits (e.g light colour) commands price premiums in a market-dependant manner (Graham et al., 2001). Export markets require uniform seed size, which may influences a range of processing properties including splitting, hydration and the quality of the final product, as it has for other food legumes (Poysa et al., 2002). In chickpea, seed size is considered as an important factor for subsequent plant growth parameters including germination, seedling vigor and seedling mass (Narayanan et al., 1981; Dahiya et al., 1985). Yield improvement and its stability are therefore, the two most important objectives for this crop (Bakhsh et al., 2006).

Materials and Methods

The experiment was conducted at research farm of the University of Agriculture Peshawar, during chickpea growing season. The experimental material consisted of ten chickpea genotypes out of which six were desi (NDC-122,NDC-4-20-1,NDC-4-20-6,NIFA-88,NIFA-95,KARAK and Karak-2) and four were Kabuli (NKC-5-S13,NKC-5-S16,NKC-5-S17,NKC-5-S24). The crop was sown using randomized complete block design (RCBD) with three replications. A plot for each genotype was 4 meter long. Each plot consists of three rows 4 meter length, with a plant to plant distance and row to row distance of 10 and 30 cm respectively. All culture practices like weeding, hoeing, irrigation were performed

same for all entries from sowing till the harvesting. Data were recorded on the following parameters on ten randomly selected plants in each plot from each replication.

1. Days to 50% flowering

Number of days to 50% flowering was recorded as the number of days from the day of sowing to the day when 50% plants in a plot show the appearance of the first flower and then average was calculated.

2. Plant height (cm)

Data on height of the randomly selected plants were recorded from the ground level to the tip of the plant with the help of meter rod. The height was measured in centimeters and then average was calculated.

3. Number of primary branches plant^{-1}

Number of primary branches were counted and expressed as number of primary branches per plant and then average was calculated.

4. Number of secondary branches plant^{-1}

Number of secondary branches were counted and then expressed as number of secondary branches per plant and then average was calculated.

5. Number of pods plant^{-1}

Number of pods per plant were taken from randomly selected plants and counted separately and then average was calculated.

6. Number of seed pod^{-1}

For number of seeds in a pod, pods were randomly selected from each plant. Number of seeds from each pod was recorded and then average number of seed pod^{-1} was calculated.

7. Number of seed plant^{-1}

The seeds obtained from the total pods selected from randomly selected plants and then average was calculated.

8.100-seed weight (g)

The seeds from selected plants were weighed in grams using an electronic balance and average was calculated.

9. Biological yield plant^{-1} (g)

At proper maturity whole plants were harvested along with grains and after sun dried the biomass of each selected plant was weighed in grams to determine biological yield (g) per plant.

10. Harvest index (%)

Harvest index was determined by using the following formula.

Harvest index =seed size / biological yield x 100

11. Seed yield plot^{-1}

The seed obtained from each plot was weighed separately in grams at appropriate moisture level.

12. Leaf area (cm^2)

Leaf area was measured with the help of leaf area meter. Data were taken randomly selected leaves from selected plants and then average was calculated.

13. Leaflets leaf^{-1}

Leaflets were counted per leaf. Data was recorded on same leaves which were selected randomly for data collection of leaf area and average was calculated.

14. Seed yield plant^{-1}

The data for seed yield plant^{-1} was recorded by weighing seeds of individual plant after harvesting using electronic balance.

15. Data Analysis

Data recorded on each parameter were analyzed statistically by using MSTATC (Steel and Torrie, 1980), analysis of variance technique to randomized complete block design, and obtaining significant differences and least significant differences (LSD) test at 5% level of probability.

Results and Discussion

Days to 50% flowering

Days to 50% flowering are an important trait which is mostly used for selecting early maturing genotypes. Early maturing genotypes can overcome the risk

of insect pest and disease attack.Highly significant differences were observed for days to 50% flowering among the chickpea genotypes (Table 1). The data was in the range of 138 to 149. Average number of days to 50% flowering was 142.2. Highest number of days was taken by NDC-4-20-1 (149 days) which is a small seed size, while the minimum days taken by NIFA-95 which is a medium seed size. The result was calculated from the mean of the genotypes. Tuba (2009) also reported significant differences for days to 50% flowering in chickpea.

Pant height (cm)

Plant height reflects the growth behavior of a crop. Besides genetic characteristics environmental factors also play vital role in determining the height of the plant.Significant differences were found among all the genotypes (Table 1). The data ranged from 53.3 to 67.8 cm, with an average plant height of 59.9 cm. Maximum plant height was recorded for NDC-4-20-6 and minimum was observed for NIFA-95 (53.3). Seed size has a significant effect on plant height. The medium seed size shows the highest plant height while the smallest plant height was shown by the small seed size chickpea. Similar results were found by Tuba (2009), Gan et al. (2003) and Belay (2009) in chickpea.

Leaf area (cm^2)

Greater leaf area can provide more surface area for photosynthesis. Data pertaining to leaf area of chickpea genotypes is indicated that analysis of variance showed significant differences for leaf area were observed among chickpea genotypes. Observed average leaf area was 5.2 cm^2. Over all genotypes showed the mean values in the range of 3.8 to 8.0 cm^2. It is evident result was calculated from the of the chickpea genotypes.

Number of secondary branches $plant^{-1}$

from the data that minimum leaf area NK-5-S13 (3.8 cm^2) while genotype NDC-122 show the maximum leaf area (8.0 cm^2). The maximum value was shown by the medium seed size genotype while the minimum value was shown by the small seed size genotype. Similar results were found by Elvis et al. (2005) in chickpea.

Leaflets $leaf^{-1}$

Data on leaflets per leaf of chickpea genotypes is presented in table 6. Statistical analysis of the data showed that significant differences for leaflets leaf were observed among genotypes. The data of the parameter for all the genotypes ranged from 12.0 to 14.9. Mean values of the data revealed that minimum leaflets per leaf (12.0) were recorded in genotypes NIFA-95. Maximum leaflets (14.9) leaflets per leaf were noted in plots sown with NDC-4-20-6. The maximum value was shown by the medium seed size chickpea genotype while the minimum value was shown by small seed size genotype. The Observed average was 13.1 leaflets per leaf. Similar results were found by Elvis et al. (2005) in chickpea.

Number of primary branches $plant^{-1}$

The analysis of variance showed highly significant differences for the number of primary branches for the chickpea genotypes (Table 1). The data of the parameter ranged from 1.6 to 4.5. The mean value for the number of primary branches $plant^{-1}$ was 2.4 branches. Highest number of branches $plant^{-1}$ were observed for NKC-5-S16 (4.5 branches $plant^{-1}$), and the minimum number of primary branches were recorded for and NKC-5-S13 (1.6 branches $plant^{-1}$) (Table 5). Medium seed size shows the maximum number of branches while the large seed size genotype shows the minimum number of primary branches. The

Data of analysis of variance showed highly significant differences for the secondary number of branches $plant^{-1}$ (Table 1). The mean table showed the ranges from

4.1 to 9.7 branches plant^{-1}. The mean of the data was 7.7 branches plant^{-1}. Highest number of branches plant^{-1} were observed for NDC-4-20-6 (9.7 branches plant^{-1}), while minimum number of branches was recorded for NDC-4-20-1 (4.1 branches plant^{-1}) (Table 5). The maximum number of secondary branches was shown by medium seed size chickpea while the minimum number of secondary branches was shown by smaller seed size chickpea. The result was calculated from the means of the genotypes.

Number of pods plant^{-1}

The number of pods plant is a major yield determining component of chickpea and contributes more towards seed yield. Highly significant differences were recorded for number of pods plant^{-1} among chickpea genotypes (Table 2). The parameter was in the range of 25 to 69.2 pods plant^{-1}. The average number of pods per plant^{-1} was 48.3 pods per plant. Maximum number of pods per plant was recorded for Karak-2 69.2 pods plant^{-1}, and lowest pods plant^{-1} recorded for NDC-4-20-1 (25 pods for plants) (Table 5). The maximum number of pods was shown by the medium seed size chickpea while the minimum number of pods was shown by the smaller seed size chickpea.

The results revealed sufficient variations among the genotypes for number of pods plant. Our findings are in agreement with those of Tawaha and Turk (2004) and Tuba (2009) in chickpea.

Number of seeds pod^{-1}

The number of seeds pod^{-1} contributes significantly towards the final seed yield in chickpea. Significant differences were observed for the numbers of seeds pod^{-1} among the genotypes (Table 2). The data was in the range of 1.0 to 1.7 seeds. The average number of seeds pod^{-1} observed was 1.3 seeds. Genotype to NKC-5-S13 exhibited maximum seeds pod^{-1} (1.7). While the minimum number of seeds pod^{-1} was observed for NKC-5-S16 (1.0 seeds pod^{-1}). The maximum number of seeds pod^{-1} was shown by the medium seed size while the minimum number of seeds pod^{-1} was shown by the large seed size genotype.

Number of seeds plant^{-1}

Significant differences were observed for the number of seeds plant (Table 2). The range was in between 34.8 to 69.5 seeds plant^{-1}, with an average of 52.6 seeds plant^{-1}. Maximum number of seeds plant^{-1} was recorded for Karak 2 (69.5) while minimum seeds plant^{-1} was observed for NDC-4-20-1 (34.8). The maximum number of seeds plant^{-1} was shown by medium seed size genotype while the minimum number of seed plant^{-1} was shown by the small seed size genotype. Tuba (2009) also reported significant differences for number of seed plant^{-1} in chickpea.

100 seed weight (g)

The weight of the seed expresses the magnitude of seed development that is an important yield determinant and plays an important role in determining the yield potential of a genotype. Highly significant differences were observed for 100-seed weight among chickpea genotypes (Table 3). Over all genotypes showed the mean values in the range of 18.4 to 31.1 g. The mean value for 100 seeds weight over all the genotypes was 24.4 g. Among the genotypes highest value for 100 seed weight was observed for NK-5-S17 (31.1g) and the lowest value was observed for NIFA-95 (18.4 g). The highest value was shown by the medium seed size genotype while the lowest by the small seed size genotype. Similar results were observed by Tawaha and Turk (2004).

Table 1. Mean square for day to 50% flowering, plant height, primary branches, secondary branches of 10 chickpea genotypes evaluated at KPK Agriculture University, Peshawar.

Source of variation	DF	Days to 50% flowering	Plant Height cm	No of primary Branches	No. of secondary branches
Reps	2	3.47	45.05	0.03	**0.63**
Genotypes	9	46.20**	95.35*	2.88**	**7.90****
Error	18	6.88	29.10	0.21	**1.71**
C.V%		**1.84**	**8.99**	**18.24**	**16.92**

**= Significant at 5% probability level,NS=Non Significant

Table 2. Mean square values for number of pod/plant, number of seeds/pod, number of seed/plant and 100 seed weight of 10 chickpea genotypes evaluated at KPK Agricultural University Peshawar.

Source ofVariation	Df	No of podsPlant-1	No of seed pod-1	No of seedplant^{-1}	100-seedWeight
Reps	2	3.46	0.08	32.93	**1.59**
Genotypes	9	684.22**	0.145*	409.17**	**47.58****
Error	18	27.36	0.05	39.04	**1.37**
C.V%		**10.82**	**16.32**	**11.65**	**4.79**

**=Significant at 5% probability level

Table 3. Mean square values for biological yield, harvest index and seed yield/plot of 10 chickpea genotypes evaluated at Agricultural University, Peshawar.

Source ofVariation	Df	Biological yieldPlant^{-1}	HarvestIndex	Seed yieldPlot^{-1}
Reps	2	4.91	41.04	**12465.83**
Genotypes	9	382.25**	108.53**	**77420.18****
Error	18	8.36	26.95	**5127.66**
C.V%		**10.67**	**12.93**	**13.76**

**=Significant at 5% probability level

Biological yield plant^{-1} (g)

The analysis of variance showed highly significant differences for biological yield plant^{-1} (Table 6). The data was in the range of 9.9 to 40.5 observed average biological yield was 27.0. Highest biological yield plant was observed for NDC-4-20-6 (40.5 g) while the minimum biological yield per plant was exhibited by NIFA 95 (9.9 g). The biological yield of a crop is the total yield of plant material. The maximum biological yield was shown by the medium seed size genotype while the minimum biological yield was shown by the small seed size genotype. The results suggested that high genetic variability was existed among the genotypes for biological yield per plant.

Harvest index

The analysis of variance showed highly significant differences for harvest index (Table 3). Data of the said parameter was in the range of 29.0 to 51.1 g per plant. Observed average harvest index was 40.1 g plant^{-1}. Highest harvest index was observed for genotype NIFA 95 (51.1 g) while the minimum harvest index was exhibited by NDC 4-20-1 (29.0g) .The maximum harvest index were shown by the small seed size genotype while the minimum harvest index were shown by the maximum seed size genotype.

Seed yield plot^{-1}(g)

The analysis of variance showed highly significant differences for the parameter among the chickpea genotypes (Table 4). Data for seed yield plot^{-1} was in the range of 290.1 to 716 g per plot. The mean value for seed yield plot^{-1} was 520.4 g. Genotype NKC-5-S17 showed highest yield plot^{-1} (716 g) and the lowest yield was observed for NKC-5-S13 (290.1 g) .The maximum seed yield plot $^{-1}$ were shown by the large seed size while the minimum seed yield plot^{-1} were shown by the small seed size genotype. Similar results were reported by Stougaard and Xue (2005).

Seed yield plant^{-1}

The analysis of variance showed significant differences for the number of seeds per plant (Table 4). Number of seeds plants^{-1} was in the range of 4.5 to 20.5 seeds per plant, with an average of 11.0 seeds per plant. Maximum number of seeds plant^{-1} was recorded for NDC-4-20-6 (20.5) while minimum number of seeds plant^{-1} was recorded for karak 2 (4.5). The maximum value was shown by the medium seed size genotype while the minimum value was shown by the small seed size chickpea genotype. Significant differences were observed for number of seeds plant^{-1}.

Table 4. Mean square values for Leaf area, Leaflets/leaf and seed yield/plant of 10 Chickpea genotypes evaluated at KPK Agriculture University Peshawar

Source ofvariation	Df	Leaf area	Leaflet leaf^{-1}	Yield plant^{-1}
Reps	2	0.06	0.23	**2.34**
Genotypes	9	9.52**	2.86**	**89.58****
Error	18	0.52	0.55	**3.49**
C.V%		**13.56**	**5.62**	**16.79**

**=Significant at 5% probability level

Table 5. Mean values for day to 50% flowering, plant height, primary branches, secondary branches, no of pod plnt-1,noof seeds pod^{-1}, no of seed plant^{-1}, 100 seed weight of 10 chickpea genotypes evaluated at KPK Agriculture University, Peshawar.

Genotypes	Days to 50% Flowering	Planth eight (cm)	No of primary branches	No of secondary branches	No of pods plnt^{-1}	No of seed pod^{-1}	No of seed plnt^{-1}	100Sw (gm)
NKC-5-S24	142	67.1	1.9	6.9	55.1	1.1	58.6	**25.9**
NKC-5-S13	148.3	59.4	1.5	7.8	31.6	1.7	42.5	**27.1**
NKC-5-S17	141	62.9	1.9	8.1	45.7	1.3	54.6	**31.1**
NKC-5-S16	140.6	66.4	4.5	7.7	51.9	1.0	54.5	**26.7**
NDC-122	146.3	57.1	1.6	7.0	28.4	1.6	39.2	**25.1**
NDC-4-20-6	142	67.8	1.6	9.7	59.4	1.4	69.4	**26.6**
Karak-2	140.1	56.0	3.4	9.0	69.2	1.3	69.5	**18.8**
NIFA-88	139.1	53.3	2.3	9.6	59.1	1.3	57.5	**21.6**
NIFA-95	138	53.3	3.5	7.1	57.7	1.4	55.5	**18.4**
NDC-4-20-1	149.3	56.5	2.3	4.1	25	1.2	34.8	**22.9**
Mean	142.67	59.9	2.4	7.7	48.3	1.3	53.6	**24.4**
LSD	**4.5**	**9.2**	**0.7**	**2.2**	**8.9**	**0.3**	**10.7**	**2.0**

Table 6. Mean values for biological yield, harvest index, and seed yield plot^{-1}, leaf area, leaflet leaf^{-1}, seed yield plant^{-1} of 10 chickpea genotypes evaluated at Agricultural University, Peshawar.

Genotypes	Bypl^{-1}(g)	HI	Syplot^{-1}g	LA	Leaflet leaf^{-1}	SY plnt^{-1}
NKC-5-S24	35.0	42.5	327.4	4.1	12.9	**14.8**
NKC-5-S13	31.5	37.7	290.1	3.8	12.8	**11.1**
NKC-5-S17	37.1	40.5	716.0	7.8	13.6	**17.1**
NKC-5-S16	34.4	41.8	358.7	4.1	12.2	**14.4**
NDC-122	28.9	35.6	640.7	8.0	14.3	**8.9**
NDC-4-20-6	40.5	35.6	681.6	7.7	14.9	**20.5**
Karak-2	10	43.2	593.5	4.4	12.0	**5.0**
NIFA-88	14.6	44.1	598.7	4.1	12.8	**6.6**
NIFA-95	9.9	51.1	610.3	3.9	12.4	**4.6**
NDC-4-20-1	28.1	29.0	387.8	5.0	14.0	**8.2**
Mean	27.0	40.1	520.4	5.2	13.1	**11.0**
LSD	**4.9**	**8.9**	**122.8**	**1.2**	**1.2**	**3.2**

Conclusions and recommendation

Conclusions

On the basis of findings obtained in this research study, it is concluded that:

1. Significant differences were observed for majority of the traits.
2. Maximum seed size genotype NDC-4-20-6 produced highest seed yield (20.5).
3. While small seed size genotype NIFA-95 (4.6) were recorded as lowest yield under Peshawar condition.

Recommendations

On the basis of conclusion given above, the following recommendations can be made.

1. Maximum seed size genotype NDC-4-20-6 is recommended for better production in Peshawar region.
2. As maximum seed size genotype NDC-4-20-6 exhibited good results for various yield components and hence could be evaluated for further improvements as well as could be utilized in further breeding programmes.

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