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Short Communication

Influence of Harvesting Stages on Seed Quality Parameters in Chickpea (*Cicer arietinum* L.) Varieties

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Chickpea (*Cicer arietinum*) is an annual plant of the *Fabaceae* family that is widely cultivated for its typically yellow-brown, pea-like seeds. It is a rich source of quality protein (20–22 %) [1]. It is one of the most important food legume plants in sustainable agriculture system because of its low production cost, wider adaptation, ability to fix atmospheric nitrogen, and fit in various crop rotations [2]. India is the fourth largest producer of chickpea contributing more than 75 per cent of the world production with a total production of 13.12 million tons from an area of 13.57 million hectare and productivity of 967 kg/ha [3]. In Gujarat it was grown in area of 0.16 million hectare with a production 0.18 million tons and productivity of 1116 kg/ha in during 2016-17 [4]. The seed reaches its maximum dry weight at physiological maturity. As such harvesting of seed crop at optimum stage of seed maturation is essential to obtain better seed quality. Moisture content of harvested crop affects seed quality and hence, it determines with which moisture content the crop should be threshed. Harvesting at high moisture content increases the changes of mycofloral infection on seed, while at low moisture content increases mechanical damage to seed [5]. Harvest of seed crop at right stage of maturity bear significant influence on seed yield and quality, as seeds harvested at right stage of physiological maturity are higher in seed quality on account of lesser field weathering [6]. There is a need to ascertain the optimum stage of harvesting to obtain higher quality seeds.

A field experiment was carried out to study the effect of stages of harvesting on seed quality parameters in chickpea at Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh during *Rabi* 2017-18. There were different six varieties (V_1 = GG 1, V_2 = GG 2, V_3 = GJG 3, V_4 = GG 4, V_5 = GG 5 and V_6 = GG 6) of chickpea were sown at 45 x 10 cm distance considered as factor-I. Harvesting was carried out at four different stages *viz.,* H_1 = Dark green colour pod stage, H_2 = Green to yellow colour pod stage, H_3 = Full yellow colour pod stage, H_4 = Copper brown colour pod stage, these four different stages of harvesting were considered as factor-II. The experiment was laid out in field as per Randomized Block Design (Factorial) with three replications. All the necessary cultural practices were carried out during crop standing. The observations on seed quality parameters in the standing crop *viz*., fresh weight of hundred pods (g), dry weight of hundred pods (g), fresh weight of hundred seeds (g) and dry weight of hundred seeds (g) were measure following standard procedure, moisture content (%) of fresh seeds were determined by the oven dry method as per the ISTA Rules [7].

The seed quality parameters depend on the stage at which the seed crop is harvested. The results of the present study on influence of stages of harvest on seed quality inchickpea varieties are presented in Table 1 and discussed here as under.

Fresh weight of hundred pods (g)

Different varieties of chickpea noticed significant difference for fresh weight of hundred pods irrespective of harvesting stages. Significantly the highest fresh weight of hundred pods (59.76 g) was recorded in GG 2. All the remaining varieties were at par with each other with the lowest fresh weight of hundred pods (49.75 g) in GG 5. This might be attributed to genetic makeup of different chickpea varieties. Such varietal differences in fresh weight of hundred pods were also reported by [8] in chickpea. Different stages of harvest exerted significant difference for fresh weight of hundred pods irrespective of different varieties tested. Significantly the highest (55.60 g) and the lowest (44.19 g) fresh weight of hundred

Table 1. Influence of stages of harvest on fresh weight of hundred pods (g), dry weight of hundred pods (g), fresh weight of hundred seeds (g), dry weight of hundred seeds (g) and moisture content (%) in chickpea varieties

Treatments	Fresh weight of hundred pods (g)	Dry weight of hundred pods (g)	Fresh weight of hundred seeds (g)	Dry weight of hundred seeds (g)	Moisture content (%)
Varieties (V)					
GG 1 (V_1)	51.63	27.47	30.44	20.13	34.56(35.28)
GG 2 (V_2)	59.76	30.29	37.67	24.16	34.94(35.49)
GJG 3 (V_3)	53.03	29.13	29.16	22.18	35.18(35.65)
GG 4 (V_4)	52.03	26.13	30.75	18.20	34.82(35.44)
GG 5 (V_5)	49.75	24.71	28.80	19.72	34.53(35.25)
GG 6 (V_6)	53.47	25.38	31.09	20.20	34.44(35.21)
S. Em+	2.06	1.08	1.33	0.68	0.19
C. D. at 5%	5.85	3.06	3.78	1.95	NS
Harvesting stages (H)					
Dark green colour pod stage (H_1)	55.60	16.21	26.17	7.58	59.95(50.72)
Green to yellow colour pod stage (H_2)	62.01	28.88	39.50	22.93	42.45(40.64)
Full yellow colour pod stage (H_3)	51.30	33.51	32.13	27.68	23.45(28.95)
Copper brown colour pod stage (H_4)	44.19	30.13	27.47	24.88	13.13(21.23)
S. Em+	1.68	0.8	1.08	0.56	0.16
C. D. at 5%	4.78	2.50	3.09	1.59	0.45
Varieties (V) × Harvesting stages (H)					
$V_1 \times H_1$	56.49	18.60	29.24	6.11	59.01(50.17)
$V_1 \times H_2$	60.25	28.15	37.76	22.91	42.56(40.71)
$V_1 \times H_3$	49.51	33.12	28.82	27.81	23.51(28.98)
$V_1 \times H_4$	40.25	30.02	25.94	23.68	13.16(21.26)
$V_2 \times H_1$	60.41	18.30	34.72	10.90	61.65(51.73)
$V_2 \times H_2$	69.01	32.70	49.23	25.62	42.03 (40.39)
$V_2 \times H_3$	58.88	38.95	36.13	30.72	23.02 (28.66)
$V_2 \times H_4$	50.72	31.20	30.59	29.40	13.06 (21.18)
$V_3 \times H_1$	54.21	18.15	21.21	10.97	61.63 (51.71)
$V_3 \times H_2$	61.72	31.95	37.58	24.38	42.35 (40.59)
$V_3 \times H_3$	53.73	35.09	32.16	27.87	23.40 (28.92)
$V_3 \times H_4$	42.46	31.34	25.68	25.50	13.34 (21.41)
$V_4 \times H_1$	56.64	14.36	23.83	5.10	58.81 (50.05)
$V_4 \times H_2$	58.43	26.92	39.92	21.11	43.44 (41.21)
$V_4 \times H_3$	49.69	32.03	31.20	24.57	23.93 (29.27)
$V_4 \times H_4$	43.35	31.20	28.06	22.03	13.09 (21.20)
$V_5 \times H_1$	51.81	14.61	23.90	7.45	59.46 (50.43)
$V_5 \times H_2$	63.14	25.22	34.95	20.95	42.15 (40.47)
$V_5 \times H_3$	43.70	31.02	29.33	27.12	23.48 (28.97)
$V_5 \times H_4$	40.33	27.99	27.02	23.38	13.02 (21.14)
$V_6 \times H_1$	54.02	13.26	24.13	4.93	59.16 (50.26)
$V_6 \times H_2$	59.50	28.35	37.54	22.60	42.14 (40.46)
$V_6 \times H_3$	52.29	30.87	35.16	27.97	23.38 (28.91)
$V_6 \times H_4$	48.05	29.03	27.54	25.32	13.10 (21.21)
Mean	53.28	27.18	31.32	20.77	34.75 (35.39)
S. Em+	4.11	2.14	2.66	1.37	0.38
C. D. at 5%	NS	NS	NS	NS	NS
CV %	13.37	13.70	14.69	11.42	1.87

Note: Figure in parenthesis are Arcsine transformed value

pods was recorded in H_2 (green to yellow colour pod stage) and H_4 (copper brown colour pod stage) harvesting stages, respectively. Such reduction in pod weight may be related to inbuilt mechanism, cessation and disorganization of cell organelles within few days from full yellow colour pod stage of harvest [9]. The results are in accordance with the findings of [10] in fenugreek, [8] in chickpea, [11] in french bean and [12] in proso millet. Interaction effect of varieties and stages of harvesting for this trait was found non-significant. However, comparatively the maximum fresh weight of hundred pods (69.01 g) was recorded by V_2H_2 followed by V_5H_2 (63.14 g) and V_3H_2 (61.72g), while the lowest fresh weight of hundred pods (40.25 g) was noted in V_1H_4.

Dry weight of hundred pods (g)

Different varieties of chickpea exhibited significant difference for dry weight of hundred pods irrespective of harvesting stages. Significantly the highest dry weight of hundred pods (30.29 g) was recorded in GG 2 and it was at par with GJG 3 (29.13 g) and GG 1 (27.45 g). All the remaining varieties were at par with each other with the lowest dry weight of hundred pods (24.71 g) in GG 5. This might be attributed to genetic makeup of different chickpea varieties. Such varietal differences in dry weight of hundred pods were also reported by [8] in chickpea. Different stages of harvest exerted significant difference for dry weight of hundred pods irrespective of different varieties tested. Significantly the highest (33.51 g) and the lowest (16.21 g) dry weight of hundred pods was recorded in H_3 (full yellow colour pod stage) and H_1 (dark green colour pod stage) harvesting stages, respectively. Such reduction in pod weight may be related to inbuilt mechanism, cessation and disorganization of cell organelles within few days from full yellow colour pod stage of harvest [9]. The results are in accordance with the findings of [10] in fenugreek, [8] in chickpea, [11] in french bean and [12] in proso millet. Interaction of effect varieties and stages of harvesting for this trait was found non-significant. However, comparatively the maximum dry weight of hundred pods (38.95 g) was recorded by V_2H_3 followed by V_3H_3 (35.09 g) and V_1H_3 (33.12 g), while the lowest dry weight of hundred pods (14.36 g) was noted in V_4H_1.

Fresh weight of hundred seeds (g)

Varieties exerted significant difference for fresh weight of hundred seeds. Irrespective of harvesting stages, significantly the highest fresh weight of hundred seeds (37.67 g) was recorded in GG 2. All the remaining varieties were at par with each other with the lowest fresh weight of hundred seeds (28.80 g) in GG 5. This might be attributed to genetic makeup of different chickpea varieties. Such varietal differences in fresh weight of hundred seeds were also reported by [13] in redgram, [8] in chickpea and [14] in groundnut. Irrespective of varieties, significantly the highest fresh weight of hundred seeds (39.50 g) was recorded, when seeds harvested at green to yellow colour pod stage (H_2) followed by full yellow colour pod stage (H_3) with 32.13 g. Fresh weight of hundred seeds was at par in remaining both the harvesting stages with the least fresh hundred seed weight (26.17 g) in dark green colour pod stage (H_1). Decrease in fresh weight of seed noticed with advance in maturity stages is mainly due to loss of moisture on account of dehydration [15]. Similar decrease in fresh weight of seeds was also reported by [13] in redgram, [10] in fenugreek, [8] in chickpea, [11] in french bean, [14] in groundnut and [12] in proso millet. Interaction effect of varieties and stages of harvesting for this trait was found non-significant. However, comparatively the maximum fresh weight of hundred seeds (49.23 g) was recorded by V_2H_3 followed by V_4H_2 (39.92 g) and V_1H_2 (37.76 g), while the lowest fresh weight of hundred seeds (21.21 g) was noted in V_3H_1.

Dry weight of hundred seeds (g)

Different varieties of chickpea exhibited significant difference for dry weight of hundred seeds irrespective of harvesting stages. Significantly the highest dry weight of hundred seeds (24.16 g) was recorded in GG 2 followed by GJG 3 (22.18 g) and GG 6 (20.20 g). The varieties GG 1, GG 2 and GG 5 were at par with each other with the lowest dry weight of hundred seeds (18.20 g) in GG 4. This might be attributed to genetic makeup of different chickpea varieties. Such varietal differences in dry weight of hundred seeds were also reported by [8] in chickpea. Different stages of harvest exerted significant difference for dry weight of hundred seeds irrespective of different varieties tested. Significantly the highest (27.68 g) and the lowest (7.58 g) dry weight of hundred seeds was recorded in H_3 (full yellow colour pod stage) and H_1 (dark green colour pod stage) harvesting stages, respectively. Such reduction in dry weight may be related to inbuilt mechanism, cessation and disorganization of cell organelles within few days from full yellow colour pod stage of harvest [9]. All the varieties attained maximum dry matter accumulation at physiological maturity [16-

18], thereafter, dry weight decreased because of restricted supply of nutrients from mother plant to seed due to disruption of vascular connection and utilization in various physiological and metabolic process [19]. Decrease in dry weight of seed noticed with advance in maturity stages is mainly due to loss of moisture on account of dehydration [15]. Similar decrease in dry weight of seeds was also reported by Kharb *et al.* (1993) in redgram, [10] in fenugreek, [8] in chickpea, [11] in french bean, [14] in groundnut and [12] in proso millet. Interaction effect of varieties and stages of harvesting for this trait was found non-significant. However, comparatively the maximum dry weight of hundred seeds (30.72 g) was recorded by V_2H_3 followed by V_6H_3 (27.97 g) and V_3H_3 (27.87 g), while the lowest dry weight of hundred seeds (4.93 g) was noted in V_6H_1.

Moisture content (%)

Different varieties of chickpea exhibited non-significant difference for moisture content of fresh seeds irrespective of harvesting stages. However, relatively the highest moisture content (35.18 %) was noted in GJG 3 followed by GG 2 (34.94 %) and GG 4 (34.82 %). The lowest moisture content was noted in GG 6 (34.44 %). Similar variations in moisture content during maturations of varieties were reported by [6, 8, 20] in chickpea, [21] in soybean, [13, 22] in pigeonpea, and [23-24] in cowpea. Different stages of harvest exerted significant difference for moisture content of fresh seeds irrespective of different varieties tested. Among the different stages of harvest, significantly the maximum moisture content (59.95 %) was recorded in fresh seeds harvested at dark green colour pod stage (H_1) followed by green to yellow colour pod stage (H_2) (42.45 %), while it was noted the minimum (13.13 %) in copper brown colour pod stage (H_4). similar decrease in moisture content with advancement in maturation stages noticed in the present study could be due to dehydration [15], which could be due to replacement of osmotic material by protein, starch and macromolecules with low hydration capacity. Similar decrease in moisture content with advance in maturity stages have been reported by [6, 16, 8] in chickpea, [25-26] in soybean, [27-28] in sunflower, [29] in clusterbean, [30-31] in cowpea, [32] in urdbean, [33] in mungbean, [34] in mustard, and [35] in groundnut. [36] also expressed that fluid and gaseous forms of nutrients and volatile substances present in seeds reduced by oxidation and volatilization along with higher rate of moisture elimination. Interaction effect of varieties and stages of harvesting for moisture content in fresh seeds was found non-significant. However, comparatively the maximum moisture content in fresh seeds (61.65 %) was recorded by V_2H_1 followed by V_3H_1 (61.63 %) and V_5H_1 (59.46 %), while the lowest moisture content (13.02 %) was noted in V_5H_4. In all the six chickpea varieties, the moisture content of seeds decreased gradually with advancement in maturity. The results are in accordance with the findings of [6, 16, 8] in chickpea and [28] in sunflower.

From the forgoing discussion, it can be concluded that fresh and dry weight of pods and moisture content recorded in fresh seeds at the time of harvesting were decreased significantly with advance in maturity, while dry weight of seeds and pods were increased up to physiological maturity and then decreased.

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