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Screening of kabuli chickpea (*Cicer arietinum* L.) germplasm resistant to Botrytis Gray Mold in Bangladesh

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Abstract

An experiment was carried out at the Pulse Research Sub-Station (PRSS), Madaripur, Bangladesh during three subsequent years of 2008-2009, 2009-2010 and 2010-2011 to screen out the suitable high yielding chickpea varieties that performed best against Botrytis gray mold under natural epiphytotic condition. Thirty three kabuli chickpea lines/varieties collected from ICARDA, Syria along with one cheek variety BARIchhola-5 were used under this experiment. The experiment was conducted in RCBD with three replications. Plant debris and *Botrytis cinerea* inocula (10^5 conidia/ml) were applied in this nursery at the flowering stage for ensuring the high disease pressure. The severity of BGM was recorded at flowering stage, pod formation stage and maturity stage. Among the 34 lines/varieties of chickpea 8, 18, 5 and 3 lines showed erect, semi erect, semi spreading and spreading type, respectively. Pigmentation of the plant was found to vary among the genotypes and observed that 24, 9 and 1 variety/lines showed stem and leaf pale green, green stem and leaf, and pre dominantly purple stem and leaf, respectively. The BGM disease severity of 34 chickpea genotypes in the field under artificial inoculated condition during three subsequent years showed wide range of disease reaction at flowering stage, pod formation stage and maturity stage and finally 10 germplasms showed Resistant (R) reaction and 24 lines showed Susceptible (S) reaction to *Botrytis cinerea*. Out of 34 variety/lines FLIP03-45C showed 99% germination in three subsequent years. In case of mean days to flowering, the lowest duration of flowering (79 days) was recorded in lines FLIP00-14C and FLIP 03-104C and highest (87 days) in line FIip98-502 (CLIMAS) and FLIP 01-63C. Mean days to maturity

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ranged from 120-128 days. The line FLIP03-141C was found early maturity (120 days). The mean plant height ranged from 35.14 – 67.85cm while the tallest plant was found in line FLIP98-206C and the shortest plant was recorded in BARIchhola-5. The highest mean number of branch (8) was recorded in ILC-1929 and the lowest number (4) in lines FLIPO2-47C and FLIPO3-36C. Number of total pods per plant ranged from 12 to 37, while the lowest number of pods (12) was recorded in FLIPO3-45C and the highest number of pods was recorded in BARIchhola-5. A significant variation 12.88-33.67g was observed among the lines/varieties in 100-seeds weight. The highest (33.67g) weight was recorded in FLIP03-141C and the lowest (12.88g) weight was recorded in BARIchhola-5. It was observed that yield performance of all the lines differs significantly. It ranged from 377-1961 kg/ha. The maximum yield (1961) was recorded in FLIP03-141C and the minimum yield was recorded in line FLIP03-36C.

Key word: Screening, chickpea, germplasm, botrytis gray mold

INTRODUCTION

Chickpea (*Cicer arietinum* L.), the world's third most important food legume, and one of the most important pulse crop in Bangladesh. Chickpea was the third most important pulse crops up to mid nineteen. But its area has gone down from 0.10 lac ha in 1990-1991 to 0.07 lac ha in 2010-2011 and ranks 7th among the pulses in Bangladesh (Krishi diary, 2012). Out of 126 diseases of pulses 17 diseases of chickpea so far recorded in Bangladesh (Bakr and Rashid 2007), Botrytis Gray Mold (BGM) caused by *Botrytis cinerea* Pers. ex. Fr., appeared as one of the most damaging diseases of chickpea in Bangladesh, which may cause 100% yield loss (Rahman and Bakr, 1998). It was first reported in 1981 in Bangladesh (Ahmed *et al*, 1981). Globally a total of 172 pathogens which include fungi, bacteria, virus, nematodes and mycoplasms like organisms (MLOs) have been recorded of chickpea growing countries of the world (Nene *et al*., 1996). Botrytis grey mould (BGM) is the second most potentially important disease of chickpea after Ascochyta blight caused by *Ascochyta rabiei* [Pass] Labour. BGM can devastate chickpea, resulting in complete yield loss in years of extensive winter rains and high humidity (Reddy *et al*., 1988; Pande *et al*., 2002). The disease is seed, soil and air borne. In the recent years, this disease has become a great threat to chickpea cultivation. Preventive measures such as low seed rate, chemical spray, wider row spacing, intercrop with linseed help to reduce disease intensity. But resistant cultivars offer the best solution to control the disease.

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Botrytis gray mold is an economically important disease of chickpea especially in cool, cloudy, and humid weather condition in the world. In Bangladesh, BGM is the most important fungal chickpea disease able to cause complete crop loss has reduced traditional cropping regions by 70% over the past decade. Several epidemics of BGM causing complete crop loss in the major chickpea-producing countries have been reported. The pathogen *B. cinerea* mainly survives between seasons on infected crop debris and seeds. Despite extensive investigations on pathological, physiological and molecular characteristics of *B. cinerea* causing gray mold type diseases on chickpea and several other hosts, the nature of infection processes and genetic basis of pathogen variability have not been clearly established. In view of the above facts, the present investigation was carried out to screen out the suitable high yielding chickpea varieties that performed the best against Botrytis gray mold.

MATERIALS AND METHODS

The experiment was conducted at the Laboratory and experimental field of Pulses Research Sub-Station (PRSS), Bangladesh Agricultural Research Institute (BARI), Madaripur, Bangladesh during three subsequent years of 2008-09, 2009-10 and 2010-11. The experimental field was high land with highly sandy loam texture belonging to the Gangatic Calcareous Flood Plan Soil. Seeds of 33 chickpea varieties/lines were collected from International Centre for Agricultural Research in the Dry Areas (ICARDA), Syria for conducting this experiment (Table 1). The collected seeds received from ICARDA were immediately stored in a well-ventilated room at room temperature. Special care was taken of the seeds and they were duly registered. After registration seeds were preserved in a refrigerator in the Pulse Pathology Laboratory till they were used for field experiment. To minimize the seed borne pathogen, seeds were treated with Provax-200 @ 5g/kg seed. The experimental plots were prepared mechanically; Weeds and other stables were removed from the field. Fertilizers were applied at the time of final land preparation as per recommended doses. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. The size of the individual plot was $2m^2$ (4 m × 0.5m). The distance between the block was 50cm. The row length was 4m and width was 25cm. BARIchhola-5 was sown as susceptible check. Insecticide 'Karate (0.2%) was applied for controlling pod borer of chickpea. The experimental fields were monitored regularly to observe the on-set of BGM of chickpea. Plant debris (stored in previous year) and *Botrytis cinerea* inocula (10^5 conidia/ml) were applied in this nursery at the flowering stage for ensuring the high disease

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pressure. The severity of BGM was recorded at flowering stage, pod formation stage and maturity stage. Botrytis gray mold of chickpea was graded on a 1-9 severity scoring scale as described by Singh (1999). This modified 1-9 scale was also adopted in case of screening for resistance against Botrytis gray mold of chickpea. The interpretation of the scales was as follows: 1 = immune or Asymptomatic (I), 2 -3 = highly resistant (HR), 4-5 = resistant (R), 6-7 = susceptible (S) and 8-9 = highly susceptible (HS). The crop was harvested at fully matured stage. Data were collected on the following parameter; plant type, plant pigmentation, plant stand by using the scale of Chickpea descriptor ICARDA & IBPGR, 1985. Data were also recorded on % germination, days to 50% flowering, days to maturity, plant height (cm), number of branch/plant, number of pods/plant, number of seeds/pod, 100 seed weight (gm), and yield (kg/ha). The collected data were analyzed statistically. Analysis of variance and LSD test were done to find out the significant difference among the treatment means.

RESULTS AND DISCUSSION

Plant type denotes the feature of erectness of plant. Data were taken before flowering stage. It varied from erect to spreading type as shown in table 1. Among the 34 lines/varieties of chickpea 8, 18, 5 and 3 lines showed erect, semi erect, semi spreading and spreading type, respectively. The erect eight lines are FLIPOI-2C, FLIPOl-4C, FLlP01-32C, FIip98-502 (climas), FLIPOI-.54C, FLIPOI-56C, FLlP02-40C and FLIP03-36C and there were no prostrate lines during three years. Pigmentation of the plant was found to vary among the genotypes. It was observed that out of 34 chickpea lines/verities 24, 9 and 1 line showed stem and leaf pale green, green stem and leaf, and pre dominantly purple stem and leaf, respectively (Table 1). Identical results were found in 9 lines (FLIPOI-30C, FLIPOI-34C, FLIPOI-38C, FLIPOI-49C, FLIP02-47C, FLIP03-45C, FLIP03-53C, FLII'03-103C, and FLIP03-104C) showed stem and leaf green and only one line FLIP03-141C showed pre dominantly purple stem and leaf. In the present study it was found that 26 lines/varieties showed very good performance i.e. these lines/varieties had the capability to service 90% or more and 3 lines performed as good, 3 lines performed as acceptable and only 2 lines/varieties very poor survival capability that means these lines/varieties have the survival capability as 80-89%, 70-79% and >60% respectively (Table 1).

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Table 1. Plant type, plant pigmentation and plant stand of Kabuli Chickpea genotypes/varieties under field condition in 2008-2011

Sl. No.	Name of Entry	Plant type	Plant pigmentation (1-9 scale)	Plant Stand
1	ILC-1929	Semi-spreading	1	Very poor
2	FLIP97-173C	Semi-erect	1	Very good
3	FLIP98-37C	Semi-erect	1	Very good
4	FLIP98-206C	Semi-spreading	1	Acceptable
5	FLIP00-14C	Spreading	1	Very good
6	FLIPOO-17C	Semi-erect	1	Very good
7	FLIPOI-2C	Erect	1	Acceptable
8	FLIPOl-4C	Erect	1	Very good
9	FLIPOI-30C	Semi-erect	3	Very good
10	FLlP01-32C	Erect	1	Very good
11	FLIPOI-34C	Spreading	3	Very good
12	FLIPOI-37C	Semi-erect	1	Very good
13	FLIPOI-38C	Semi-spreading	3	Very good
14	FLIPOI-49C	Semi-spreading	3	Very good
15	FIip98-502 (climas)	Erect	1	Very good
16	FLIPOI-.54C	Erect	1	Very good
17	FLIPOI-56C	Erect	1	Very good
18	FL1P01-60C	Semi-erect	1	Very good
19	FLIPOI-63C	Semi-erect	1	Very good
20	FLIP02-39C	Semi-erect	1	Good
21	FLlP02-40C	Erect	1	Very good
22	FLIP02-47C	Semi-erect	3	Good
23	FLIP03-36C	Erect	1	Good
24	FLlP03-42C	Semi-erect	1	Very good
25	FLIP03-45C	Semi-spreading	3	Very good
26	FLIP03-53C	Semi-erect	3	Very poor
27	FLII'03-103C	Spreading	3	Very good
28	FLIP03-104C	Semi-erect	3	Very good
29	FLIP03-106C	Semi-erect	1	Acceptable
30	FLIP03-118C	Semi-erect	1	Very good
31	FLIP03-119C	Semi-erect	1	Very good
32	FLIP03-134C	Semi-erect	1	Very good
33	FLIP03-141C	Semi-erect	7	Very good
34	BARIchola-5	Semi-erect	1	Very good

Plant pigmentation:
1 = Stem and leaf pale green, 3 = Stem and leaf green , 5 = Stem and leaf partially purple, 7 = Stem and leaf pre dominantly purple, 9= Stem and leaf highly purple.

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BOTRYTIS GRAY MOLD DISEASE REACTION DURING 2008-2009 to 2010-2011

Disease severity at flowering, pod formation and maturity stage: The BGM disease severity of 34 chickpea genotypes in the field under artificial inoculated condition during 2008-09, 2009-10 and 2010-11 showed wide range of disease reaction against Botrytis gray mold ranged from 2.00-4.00, 2.00-4.50 and 2.00-4.00, respectively at flowering stage (Table 2). The variation 2.00–4.00, was the average of three years that was not much a significant difference. At pod formation stage, during three successive years BGM disease severity ranged from 2.00-6.00, 2.00-6.50 and 2.00-6.50, respectively. The mean disease severity of three years varied 2.00-6.50. At maturity stage during three successive years BGM disease severity ranged from 4.00-7.00, 4.00-8.00 and 4.00-7.00, respectively. The mean disease severity of three years ranged from 4.00-7.00. And finally 10 germplasms showed Resistant (R) reaction and 24 lines showed Susceptible (S) reaction to *Botrytis cinerea*. These findings corroborate with the findings of other researchers. Singh *et al*. (1997) screened 2550 chickpea lines were in a growth chamber in 1992-1995. Five chickpea lines were found resistant. Thirteen lines were found to be resistant to moderately resistant. Hossain *et al.* (1997) and Pande *et al*. (1998) studied the susceptibility of BGM on Chickpea and recorded some genotypes with lesser susceptibility to the disease. The finding of the present study revealed that the tested chickpea lines/varieties showed different types of reaction to Botrytis gray mold under field condition. The variation in respect of disease reaction among the chickpea lines/varieties from ICARDA, Syria might be due to i) genetic variation among the lines/varieties that govern the resistance mechanism of plant against Botrytis gray mold ii) variation of the pathogenic strain/races of *Botrytis cinerea*. Reddy *et al*. (1993) reported that Chickpea genotypes with erect and compact growth habit had less BGM compared with genotypes with bushy and spreading growth habit. This effect of compact plant type on BGM disease is attributed to the differences in micro-climatic conditions. Bakr, *et al.* (1997) reported that bushy and dense canopy, resulting from close spacing and spreading type of plants favors the development of BGM, as these condition resulted high humidity.

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Germination (%): In the present study it was found that out of 33 Kabuli chickpea lines/varieties and one check variety, in the field trials conducted during 2008-09, 2009-10 and 2010-11, 7 lines/varieties showed above 90% germination *viz.* ILC-1929, FLIP98-206C, FLIP00-14C, FLIP01-30C, FLIP02-40C, FLIP03-45C and BARIchhola-5. Out of these FLIP03-45C showed 99% germination in three subsequent years (Table 3).

Days to 50% flowering and maturity: Days to 50% flowering of 34 chickpea genotypes in the field trials conducted during 2008-09, 2009-10 and 2010-11 ranged 81-89, 76-89 and 78-89, respectively. The ranges in days to maturity of the genotypes were 121-127, 115-130 and 121-127. The average of three years trials showed that 10 lines showed resistant reaction and 24 lines showed susceptible reaction to BGM under high disease pressure at field condition (Table 3).

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Table 2. Disease severity of Kabuli Chickpea germplasm collected from ICARDA, Syria against Botrytis gray mold under artificial inoculation in the field during 2008-09 to 2010-11.

Name of entry	**Flowering stage**				**Pod formation stage**				**Maturity stage**				Final disease reaction
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	
ILC-1929	3.00	3.50	3.00	3.00	4.50	4.00	4.00	4.00	6	7	6	6	S
FLIP97-173C	3.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	5	5	5	5	R
FLIP98-37C	2.00	2.00	2.00	2.00	2.50	2.00	2.00	2.00	4	6	4	5	R
FLIP98-206C	3.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	6	4	6	5	R
FLIP00-14C	3.00	3.50	3.00	3.00	5.00	4.00	4.50	4.50	6	6	6	6	S
FLIPOO-17C	4.00	3.50	4.00	4.00	5.00	5.00	5.00	5.00	6	5	6	6	S
FLIPOI-2C	3.00	3.50	3.00	3.00	5.50	4.00	4.00	4.50	7	6	7	7	S
FLIPOl-4C	3.00	3.00	3.00	3.00	5.50	4.00	4.00	4.50	7	6	7	7	S
FLIPOI-30C	3.00	2.50	3.00	3.00	5.00	3.00	4.00	4.00	6	5	6	6	S
FLlP01-32C	2.50	2.50	2.50	2.50	5.00	3.00	4.00	4.00	6	6	6	6	S
FLIPOI-34C	2.50	2.50	2.50	2.50	3.50	2.00	2.00	2.50	6	5	6	6	S
FLIPOI-37C	2.00	2.00	2.00	2.00	3.00	2.00	2.00	2.50	5	6	5	5	R
FLIPOI-38C	2.00	2.50	2.00	2.00	3.50	3.00	3.00	3.00	6	6	6	6	S
FLIPOI-49C	2.00	2.00	2.00	2.00	3.00	3.00	3.00	3.00	6	6	6	6	S
Flip98-502 (climas)	2.50	3.00	2.50	2.50	4.50	4.00	4.00	4.00	6	6	6	6	S
FLIPOI-.54C	3.00	3.50	3.00	3.00	4.00	4.00	4.00	4.00	5	7	5	6	S
FLIPOI-56C	3.00	3.00	3.00	3.00	6.00	5.00	5.00	5.00	7	7	7	7	S
FL1P01-60C	2.50	3.00	2.50	2.50	5.00	4.00	4.00	4.00	6	6	6	6	S
FLIPOI-63C	2.50	3.00	2.50	2.50	4.00	4.00	4.00	4.00	5	6	5	5	R
FLIP02-39C	3.00	3.00	3.00	3.00	5.00	4.00	4.00	4.00	6	5	6	6	S
FLlP02-40C	2.50	3.00	2.50	2.50	5.00	4.00	4.00	4.00	6	6	6	6	S
FLIP02-47C	3.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	5	5	5	5	R
FLIP03-36C	3.00	3.50	3.00	3.00	4.00	6.00	6.00	5.00	5	6	5	5	R
FLlP03-42C	4.00	4.50	4.00	4.00	5.00	4.50	4.50	4.50	6	6	6	6	S
FLIP03-45C	3.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	5	6	5	5	R
FLIP03-53C	2.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	4	5	4	4	R
FLII'03-103C	2.00	2.50	2.00	2.00	4.00	3.00	3.00	3.00	5	4	5	5	R
FLIP03-104C	2.00	2.50	2.00	2.00	5.00	4.00	3.00	4.00	6	5	6	6	S
FLIP03-106C	2.50	3.00	2.50	2.50	5.00	4.00	4.00	4.00	6	5	6	6	S
FLIP03-118C	2.50	2.50	2.50	2.50	5.00	4.00	4.00	4.00	6	6	6	6	S
FLIP03-119C	2.00	3.00	3.00	3.00	4.50	3.00	3.00	3.50	6	5	6	6	S
FLIP03-134C	2.50	3.00	2.50	2.50	4.00	5.00	5.00	5.00	6	6	6	6	S
FLIP03-141C	3.00	3.00	3.00	3.00	4.50	4.00	4.00	4.00	7	7	7	7	S
BARIchola-5	3.5	4.00	4.00	4.00	6.00	6.50	6.50	6.50	6	8	6	6	S

The interpretation of the scales was follows: 1 = immune of Asymptomatic (I), 2–3= highly resistant (HR), 4-5 = resistant (R), 6-7= susceptible (S) and 8-9= highly susceptible (HS)

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Table 3. Performance of Kabuli Chickpea genotypes regarding % germination, days to 50% flowering and days to maturity in the field in 2008-09 to 2010-2011

Name of entry	% Germination				Days to 50% flowering				Days to Maturity			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
ILC-1929	90	93	91	91	81	77	82	80	125	121	125	123
FLIP97-173C	40	45	43	42	81	82	83	82	126	124	124	125
FLIP98-37C	60	65	62	62	82	80	86	83	121	119	125	122
FLIP98-206C	90	95	93	93	88	87	81	85	124	128	126	126
FLIP00-14C	90	94	92	92	81	76	81	79	127	125	125	126
FLIPOO-17C	45	50	48	49	85	81	81	82	126	126	127	126
FLIPOI-2C	75	80	77	77	87	88	82	86	125	125	125	125
FLIPOl-4C	85	90	88	87	83	87	88	86	124	125	125	125
FLIPOI-30C	90	92	89	90	84	83	81	82	124	126	124	125
FLlP01-32C	69	74	71	71	89	87	85	86	126	127	125	126
FLIPOI-34C	80	83	79	80	87	84	87	85	125	128	125	126
FLIPOI-37C	80	86	84	83	86	88	83	86	126	128	125	126
FLIPOI-38C	75	78	79	77	87	85	84	85	126	124	126	125
FLIPOI-49C	80	84	81	81	85	84	89	86	124	124	126	124
Flip98-502 (climas)	80	85	83	83	86	89	87	87	126	127	127	127
FLIPOI-.54C	80	85	80	82	84	87	86	86	125	127	127	126
FLIPOI-56C	85	90	91	88	83	85	87	85	124	127	125	125
FL1P01-60C	70	75	73	73	86	87	85	86	125	128	121	125
FLIPOI-63C	75	76	71	73	86	89	86	87	126	130	125	127
FLIP02-39C	55	60	58	58	83	88	84	85	125	129	125	126
FLlP02-40C	90	92	89	90	88	86	83	86	127	130	126	128
FLIP02-47C	80	86	83	83	84	86	86	85	125	127	121	124
FLIP03-36C	65	70	68	68	85	87	86	86	125	128	124	126
FLlP03-42C	75	77	76	76	83	86	83	84	124	128	127	126
FLIP03-45C	100	98	99	99	85	81	88	85	125	126	126	126
FLIP03-53C	85	88	83	85	85	84	84	84	125	126	125	126
FLII'03-103C	65	72	69	69	83	82	85	83	125	127	124	125
FLIP03-104C	60	66	64	63	78	77	83	79	126	130	124	127
FLIP03-106C	60	65	62	63	85	82	85	84	126	130	126	127
FLIP03-118C	64	70	69	66	83	81	85	83	127	124	125	125
FLIP03-119C	85	86	85	85	82	79	83	81	127	130	126	128
FLIP03-134C	60	66	65	63	83	84	78	82	125	128	126	126
FLIP03-141C	50	55	53	53	86	83	85	85	121	115	124	120
BARIchola-5	90	93	91	91	81	77	83	80	125	121	126	124
CV (%)	22.89	21.77	22.13	-	3.00	1.14	2.88	-	1.51	0.85	1.49	-
LSD (0.05)	11.04	11.37	11.11	-	5.22	1.96	3.25	-	3.81	2.19	3.78	-

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Plant height and number of branch per plant:

The tested 34 lines/ varieties showed significant differences in respect of plant height to each other in field condition. The plant height ranged from 35.14-67.85 cm while the tallest (67.85 cm) plant was found in line FLIP98-206C and the shortest plant (35.14 cm) was recorded in BARIchhola-5. Number of branch per plant was counted as the primary branch of plant that is the first branching of the plant. It was found that most of the lines/varieties gave five primary branches. Number of branches per plant varies from 4-8. The highest number of branch (8) was recorded in ILC-1929 and the lowest number (4) in lines FLIPO2-47C and FLIPO3-36C. (Table 4)

Number of pods per plant and number of seeds per pod:

Number of total pods per plant was recorded just after harvesting of plants by counting the pods from ten (10) plants in every lines/varieties. Number of total pods per plant ranged from 12 to 37, while the lowest number of pods (12) was recorded in FLIPO3-45C and the highest number of pods was recorded in BARIchhola-5. Number of seeds per pod was counted after harvesting plants by counting the seeds from ten (10) pods in randomly of every lines/varieties. Number of seeds per pod ranged from 1 to 1.27, while the highest (1.27) number of seeds per pod was recorded in BARIchhola-5 and the lowest (1) was recorded in FLIP00-14C, FLIP01-2C, FLIP0-4C and FLIP03-53C. (Table 4,5).

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Table 4. Performance of Kabuli Chickpea genotypes regarding plant height, no. of branch/plants and no. of pods/plant in the field in 2008-2011.

Name of entry	Plant height (cm)				No. of branch/plant				No. of pods/plant			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
ILC-1929	46.50	50.15	48.88	48.51	7.50	7.75	7.30	8	19.00	21.15	20.11	20
FLIP97-173C	55.85	51.85	54.21	53.97	7.45	6.65	6.70	7	21.30	21.65	21.02	21
FLIP98-37C	55.85	57.85	55.59	56.43	7.30	6.80	6.00	7	21.90	22.25	22.45	22
FLIP98-206C	68.70	66.75	68.23	67.85	5.70	6.60	5.40	6	17.40	18.00	18.33	18
FLIP00-14C	48.80	46.85	48.05	47.90	6.00	5.80	5.50	6	17.10	19.20	18.03	18
FLIPOO-17C	52.50	56.70	54.09	54.43	5.40	4.60	4.60	5	17.65	20.40	19.33	19
FLIPOI-2C	60.70	62.35	62.09	61.71	5.00	4.55	5.20	5	13.40	15.60	14.88	15
FLIPOl-4C	62.90	64.00	63.00	63.30	4.60	4.50	5.20	5	12.40	14.20	12.88	13
FLIPOI-30C	61.60	65.20	64.32	63.71	5.20	5.50	5.00	5	13.00	14.30	14.00	14
FLlP01-32C	61.90	63.70	61.78	62.46	5.20	4.95	5.20	5	19.60	21.40	22.00	21
FLIPOI-34C	59.00	64.80	62.33	62.04	5.00	5.35	6.20	6	13.30	15.80	14.20	14
FLIPOI-37C	58.40	62.15	60.03	60.19	5.20	5.75	4.30	5	13.60	15.25	14.11	14
FLIPOI-38C	58.20	62.05	61.21	60.49	6.20	5.50	5.45	6	18.70	20.65	21.13	20
FLIPOI-49C	59.33	62.10	61.07	60.83	5.00	4.95	5.90	5	18.20	21.05	21.43	20
Flip98-502 (climas)	61.60	66.10	64.85	64.40	5.60	4.30	5.40	5	13.30	15.40	14.12	14
FLIPOI-.54C	59.00	63.50	62.03	61.51	5.10	4.45	5.05	5	12.30	13.40	13.33	13
FLIPOI-56C	56.90	59.55	61.21	59.22	5.20	4.90	5.20	5	14.00	16.70	15.69	15
FL1P01-60C	59.90	64.80	61.82	62.17	6.20	5.80	5.60	6	16.20	18.35	17.22	17
FLIPOI-63C	58.50	62.95	61.41	60.95	5.40	5.05	4.95	5	17.00	17.30	17.00	17
FLIP02-39C	59.15	63.30	62.01	61.49	6.00	5.20	5.90	6	22.00	20.40	21.88	21
FLlP02-40C	47.70	49.45	49.02	48.72	6.10	5.40	9.20	7	18.20	20.85	19.98	20
FLIP02-47C	49.00	55.65	53.85	52.83	4.40	4.05	4.90	4	15.00	17.60	16.66	16
FLIP03-36C	53.60	59.30	57.42	56.77	4.80	4.35	4.15	4	19.00	18.15	19.23	19
FLlP03-42C	57.20	62.40	59.64	59.75	5.00	4.30	5.45	5	15.20	17.10	16.22	16
FLIP03-45C	52.00	55.30	54.71	54.00	4.00	5.35	5.10	5	10.60	12.95	13.43	12
FLIP03-53C	60.80	65.60	64.22	63.54	4.80	5.45	4.30	5	16.00	18.60	18.00	18
FLII'03-103C	54.30	58.75	56.48	56.51	5.00	5.95	5.30	5	20.10	22.07	22.09	21
FLIP03-104C	54.20	59.10	56.27	56.52	5.60	4.90	4.95	5	15.50	17.00	16.63	16
FLIP03-106C	51.00	53.90	55.64	53.51	4.30	4.15	5.35	5	15.71	17.35	18.46	17
FLIP03-118C	48.80	51.35	54.33	51.49	6.20	5.45	5.75	6	13.80	15.10	14.72	15
FLIP03-119C	51.10	53.80	49.58	51.49	5.20	5.10	5.50	5	15.00	17.15	16.33	16
FLIP03-134C	45.70	49.25	47.22	47.39	5.90	4.30	4.95	5	22.60	17.80	21.89	21
FLIP03-141C	40.20	43.70	41.56	41.82	4.40	5.30	4.30	5	13.10	16.24	15.46	15
BARIchola-5	36.22	34.22	34.98	35.14	5.83	6.00	4.45	5	36.05	37.00	38.88	37
CV (%)	5.17	3.25	5.29	-	23.79	12.19	13.22	-	21.61	13.53	16.66	-
LSD (0.05)	9.98	4.86	6.63	-	2.69	1.27	1.89	-	9.24	7.05	5.44	-

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100-seed weight (g) and Grain yield (Kg/ ha):

The weight of 100-seed weight was recorded in all the lines. A significant variation was observed among the lines/varieties in 100-seeds weight. It ranged from 12.88-33.67g. The highest (33.67g) weight was recorded in FLIP03-141C and the lowest (12.88g) weight was recorded in BARIchhola-5. It was observed that yield performance of all the lines differs significantly. It ranged from 377-1961 kg/ha. The maximum yield (1961 kg/ha) was recorded in FLIP03-141C and the minimum yield was recorded in line FLIP03-36C. (Table 5).

Table 5. Performance of Kabuli Chickpea genotypes regarding no. of seeds/pod, 100 seed weight (gm) and yield in the field in 2008-2011.

Name of entry	No. of seeds/pod				100 seed wt.(gm)				Yield (kg/ha)			
	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean	2008-09	2009-10	2010-11	Mean
ILC-1929	1.20	1.05	1.10	1.12	28.25	29.50	25.45	27.73	556	573	562	564
FLIP97-173C	1.20	1.10	1.05	1.12	30.45	32.50	29.80	30.92	1150	1125	1145	1140
FLIP98-37C	1.10	1.05	1.10	1.08	25.45	28.00	29.60	27.68	1176	1155	1123	1151
FLIP98-206C	1.00	1.05	1.05	1.03	29.80	32.50	29.00	30.43	1067	1035	1016	1039
FLIP00-14C	1.00	1.00	1.00	1.00	29.60	34.50	29.75	31.28	1175	1168	1125	1156
FLIPOO-17C	1.10	1.00	1.10	1.07	29.00	32.50	29.90	30.47	912	905	902	906
FLIPOI-2C	1.00	1.00	1.00	1.00	29.75	29.50	29.55	29.60	598	583	578	586
FLIPOl-4C	1.00	1.00	1.00	1.00	29.90	28.50	27.50	28.63	662	658	680	667
FLIPOI-30C	1.20	1.00	1.10	1.10	29.55	31.00	30.40	30.32	722	715	744	727
FLlP01-32C	1.00	1.00	1.05	1.02	27.50	31.00	31.65	30.05	610	600	590	600
FLIPOI-34C	1.10	1.00	1.05	1.05	30.40	30.50	32.55	31.15	804	798	794	799
FLIPOI-37C	1.10	1.00	1.10	1.07	31.65	26.50	27.45	28.53	521	510	509	513
FLIPOI-38C	1.20	1.10	1.20	1.17	32.55	30.00	33.30	31.95	711	698	730	713
FLIPOI-49C	1.20	1.15	1.10	1.15	27.45	30.00	30.20	29.22	1210	1195	1235	1213
Flip98-502 (climas)	1.10	1.05	1.15	1.10	33.30	28.50	32.95	31.58	483	473	453	470
FLIPOI-.54C	1.20	1.00	1.10	1.10	29.75	30.50	33.20	31.15	700	690	633	674
FLIPOI-56C	1.20	1.00	1.10	1.10	29.90	29.00	35.10	31.33	672	665	652	663
FL1P01-60C	1.10	1.00	1.10	1.07	29.55	30.00	30.20	29.92	475	463	466	468
FLIPOI-63C	1.10	1.00	1.05	1.05	27.50	27.50	28.60	27.87	611	600	624	612
FLIP02-39C	1.20	1.05	1.10	1.12	30.40	30.50	22.85	27.92	512	505	500	506
FLlP02-40C	1.00	1.10	1.00	1.03	31.65	31.00	33.10	31.92	542	528	513	528
FLIP02-47C	1.20	1.00	1.10	1.10	32.55	30.50	26.50	29.85	1386	1373	1368	1376
FLIP03-36C	1.10	1.05	1.10	1.08	27.45	28.00	25.45	26.97	387	378	366	377
FLlP03-42C	1.30	1.00	1.20	1.17	33.30	34.00	29.80	32.37	812	808	800	807
FLIP03-45C	1.00	1.00	1.05	1.02	30.20	31.00	29.60	30.27	1512	1505	1535	1517
FLIP03-53C	1.00	1.00	1.00	1.00	32.95	32.00	29.00	31.32	428	420	406	418
FLII'03-103C	1.00	1.00	1.10	1.03	33.20	32.50	29.75	31.82	1110	1075	1080	1088
FLIP03-104C	1.10	1.05	1.05	1.07	26.50	25.00	32.55	28.02	1289	1275	1188	1251
FLIP03-106C	1.20	1.05	1.10	1.12	30.20	31.50	29.55	30.42	875	863	884	874
FLIP03-118C	1.20	1.20	1.15	1.18	28.60	29.00	27.50	28.37	1220	1205	1200	1208
FLIP03-119C	1.10	1.00	1.15	1.08	22.85	23.50	30.40	25.58	1152	1143	1133	1143
FLIP03-134C	1.10	1.00	1.05	1.05	33.10	34.00	31.65	32.92	745	748	712	735
FLIP03-141C	1.20	1.30	1.25	1.25	35.10	36.00	29.90	33.67	1995	1983	1905	1961
BARIchola-5	1.30	1.20	1.30	1.27	12.99	13.22	12.44	12.88	1325	1234	1300	1286
CV (%)	6.39	5.97	4.68	-	7.65	2.99	5.52	-	12.23	16.52	13.34	-
LSD (0.05)	0.31	0.13	0.87	-	0.96	1.96	2.31	-	264.7	289.8	278.4	-

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Conclusion: From the three years trials, it may be concluded that the kabuli chickpea genotypes FLIP03-45C (1517 Kg/ha), FLIP02-47C (1376 Kg/ha), FLIP98-37C (1151 Kg/ha), FLIP97-173C (1140 Kg/ha), FLIP03-103C (1088 Kg/ha) and FLIP98-206C (1039 Kg/ha) produced highest grain yield and low BGM infestation. Therefore, the genotype FLIP03-45C could be considered for investigation at southern part of Bangladesh to release it as a chickpea variety.

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