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VARIETAL SCREENING FOR TOLERANCE AGAINST LEAF ROLLER OF MUNGBEAN UNDER FIELD CONDITION

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Abstract

An experiment was carried out in the farmer's field at Sonakhali, Barguna sadar, Barguna of Bangladesh during January to April 2016 to evaluate different varieties of mungbean against leaf roller in order to find out tolerant/less susceptible varieties of mungbean. Results revealed that all varieties regarding leaf roller population the variety, local Mung, IPSA Mung-5, BU Mung-2 and BINA Mung-2 had highest population of leaf roller and were highly susceptible varieties to leaf roller. The varieties, BARI Mung-2, GK Mung-27, BU Mung-1 and IPSA Mung-12 had lowest population of leaf roller, which indicated that these varieties were least susceptible to leaf roller. Among all tested varieties, none showed complete resistance against leaf rollers but BARI Mung-5 and BARI Mung-6 showed comparatively better resistance against leaf roller. The highest population of leaf roller/m^2 (7.0) plants in the field was observed in the 2nd week of March and then declined gradually up to the 4th week of March in 2016. BARI Mung- 6, BINA Mung-2, BU Mung- 1 and local Mung varieties had the highest percent leaf area damage by leaf roller while IPSA Mung-5, GK Mung-27, BARI Mung-5 and BU Mung-2 varieties had the lowest percent leaf area damage by leaf roller. There was a strong negative correlation between number of leaf roller and yield.

Keywords: Damage, Leaf roller, Mungbean, Susceptible, Tolerance

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] belongs to Fabaceae family and usually it is known as green gram (Patel *et al*., 2014). It is one of the most important pulses in south-east Asia (Mondal et al., 2013). However, its yield is much lower than that of other legume crops such as grasspea, chickpea and lentil (FAO 2007). It is one of the leading legume crops widely grown in Bangladesh during Rabi season as well as in many tropical and subtropical countries of the world (Asante *et al.*, 2002). In Bangladesh, the area under pulse crops in Bangladesh is 0.372 million hectares with a production of 0.425 million tons but 0.041million hectares of land are under mung bean cultivation where its

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production is 0.044million tons (BBS, 2021) which is lower than any major vegetables. It is considered as a quality pulse in the country but production perunit area is very low (931 kg/ha) as compared to other countries of the world (BBS, 2021). It ranks fifth both in acreage and production and contributes 6.5% of the total pulse production in Bangladesh (Alam *et al.,* 2021). It is highly nutritious pulse crop contain 24 per cent protein, 59.9 per cent carbohydrate and 40-70 ppm iron contents, considered it an ultimate resort for balanced diets (Selvi *et al.,* 2006 and Vairam *et al.,* 2016). It is a good source of proteins, carbohydrates and vitamins for the human race all over the world. It contains 51% carbohydrate, 26% protein, 10% water, 4% minerals and 3% vitamins (Kaul, 1982) like other pulses widely used as 'Dal' in Bangladesh. Mungbean seed have higher percentage of protein (28.5%), fiber (0.95%), fats (0.65%) and ash (3.75%) (Monem *et al.*, 2012). It is protein rich and also contains amino acid lysine, which is generally deficiet in food grains (Elias *et al.,* 1986). After chickpea, it is called as poor people diet owing to its protein nature and is meeting the major protein demand of the people (Shafique *et al.,* 2009). Besides these, it has the ability to fix the atmospheric nitrogen in symbiotic association with Rhizobium bacteria (Ali and Ahmad, 1993). Mungbean has ability to endure water scarcity conditions because of its short life cycle it can be adjusted in cropping systems of spring and summer crops (Raina *et al.,* 2016). A number of insect pests adversely affect the production of mung bean. According to the report of Rahman *et al.* (2000), more than twelve species of insect pests were found to infest mung bean in Bangladesh among which stem fly, flea beetles, flower thrips and pod borers cause serious damage. These insect pests attack the crop from seedling to fruiting stage and are responsible to cause significant yield loss (Hossain, 2015). The infestation of these insect pests inflicts serious economic loss causing annual yield loss about 27.03 to 38.06% in India (Duraimurugan and Tyagi, 2014). The most damaging insect pests of mungbean recorded so far are stem fly (Rahman,1987), jassid (Baldev *et al*., 1988), whitefly (Rahman *et al*., 1981), thrips (Chhabra and Kooner, 1985), hairy caterpillar (Rahman *et al.,* 1981) and pod borer (Nair,1987). Out of several insect pests, leaf folder/roller is one of the important insect pest causing severe damage from seedling to vegetative stages of mungbean. In mungbean larvae of leaf folder fold the leaves and feed on green tissues (the mesophyll layer) of the leaf causing in the appearrance of linear, pale white stripe damage. Ultimately the damaged leaves dry up or even plant may die. At present day, management of insect pest has largely been relied on chemical control. However, the demands for clean and ecologically sound control envisages, careful planning for rationalizing the insecticides interventions. Variety plays an important role in producing high yield of mungbean because different varieties perform differently for their genotypic characters also vary from genotype to genotype.

Development of resistant varieties is an ideal component against buildup of pest population at no additional cost, compatible with other methods of pest control and free from control pollution. Various biophysical and biochemical characters of the plants play an important role by providing resistance against this pest. The exploitation of host plant resistance, an economically viable genotypes measure against insect pests has become imperative to find out resistance source with higher yield (Tamang *et al*., 2017). Keeping this in view, the present study was carried out to evaluate 10 varieties to find out tolerant/less susceptible varieties of mungbean against leaf roller.

Materials and Methods

Field experiment was carried out in the farmer's field at Sonakhali, Barguna sadar, Barguna of Bangladesh during January to April 2016 to find out tolerant/less susceptible varieties of mungbean against leaf roller. Randomized block design with three replications was used (Gomez and Gomez, 1984). The 10 varieties include BARI Mung-2, BARI Mung-5, BARI Mung-6, BU Mung-1, BU Mung-2, IPSA Mung-5, IPSA Mung-12, GK Mung-27, BINA Mung-2 and local Mung were used as study materials. The land was prepared at 'Joe' condition by 3 times deep ploughing and cross ploughing followed by laddering with a power tiller until the desired tilth during the last week of January, 2016. All the weeds, residues and stubbles of the previous crops were removed from the field. After leveling, the land was leveled and the experimental plot was partitioned into the unit plots in accordance with the experimental design. The whole field was divided into 3 unit blocks representing 3 replications. Each unit block was divided into 10 sub unit plots. The total number of plots was 30 and the size of the individual plot was 3.0m x 2.0m. The distance between unit plots was 0.75m and between blocks was 1.0m. The treatments were randomly assigned to the plots within a block. The seeds were sown on 1 February 2016 at the rate of 20 kg/ha. The seeds were placed in the line continuously at a depth of 4-5cm and covered by loose soil with the help of hand. The spacing was 15 cm between rows and 10 cm between plants. Intercultural operations were done as and when necessary to ensure normal growth and development of crops. Irrigation was applied as and when needed. Proper drainage system was also developed for draining out excess water. As the seeds were sown continuously into the line, there were so many seedlings which needed thinning. Emergence of seedling was completed within 10 days after sowing. Overcrowded seedlings were thinned out twice to keep plant to plant distance about 10 cm. First thinning was done after 15 days of sowing which was done to remove unhealthy and out of line seedlings. The second thinning was done at 10 days after the first thinning. There were some common weeds found in the mungbean field. First weeding was done at 30 DAS (days after sowing) followed by once a week to keep the plots free from weeds and to keep the soil loose and aerated for the whole period of the crop growth.

Data collection procedure:

Weekly data were collected and recorded by direct counting early in the afternoon (4.0 – 6.0 pm). The observations were made at 15 DAS and continued till maturity of the crop at weekly intervals on randomly selected 10 plants from each variety. The population of leaf roller was collected four times (23 DAS, 30 DAS, 37 DAS and 44 DAS) from seedling to flowering. Infested mungbean plants were recorded at vegetative and reproductive stage. The total number of infested plants was recorded from the selected 1 m^2 area of the center of each unit plot to determine the level of infestation by leaf roller.

The leaf area of 5 representative leaves from randomly selected 5 plants of each unit plot was recorded on leaf area meter (Model LI-3100C) and the mean leaf area was computed. Percentage of damaged leaves area/plant by leaf roller were determined by eye estimation. Infestation of mungbean leaves /plant was recorded at different periods of plant growth (at different DAS). The total damaged leaves area was counted and percentage of damaged leaves area was calculated from selected and taged plants of each plot. These include 3 healthy leaves and 2 infested leaves. Mean value of them was recorded as each plot wise and expressed in cm^2.

The percentage of damaged leaves area was calculated by the following formula:

Percentage of damaged leaves area = $\frac{B}{A} \times 100$

Where,

A= Total leaves area checked per plant

B= Damaged leaves area per plant

$$\% \text{ damage leaves area} = \frac{\text{Damage leaves area per plant}}{\text{Total leaves area checked per plant}} \times 100$$

Harvesting and Seed preservation

Mungbean plant produces flower over an extended period. For this reason, pod maturity of mungbean is not uniform which makes it difficult to the harvesting time of mungbean. Generally, harvest should begin when one half to two-thirds of the pods are mature. Pod should be picked after it become black in color. Mungbean was harvested thrice at 65-72 DAS. First only ripen pods were harvested at 65 DAS (4th April 2016) when about 80% of the pods became black in color. After first picking, flowering appeared and pod formation occurred second time. These pods were harvested at 72 DAS (second time on 11th April 2016) after ripening. The harvested crop of 1 m^2 area from each unit plot was bundled separately. Grains were recorded from 1 m^2 area per plot wise and the yields were expressed in kilogram (kg) per hectare. Mungbean was properly stored because seed is vulnerable to heavy bruchid damage. The seeds were cleaned, dried thoroughly in sun keeping moisture content below 8-9 %. Then seeds were cooled and kept either in sealed polythene bags along with naphthalene balls covered by jute bags, tin containers or air tight earthen pots in store rooms. Finally, seeds were stored in cool dry place above the ground.

Meteorological data

Meteorological data in respect of temperature, relative humidity and rainfall for experimental period were collected from Meteorological office, Kalapara, Patuakhali.

Statistical analysis

The collected data were analyzed following the analysis of variance (ANOVA) using WASP program and the mean differences were adjudged by CD (critical difference) values.

Results and Discussion

The results of the experiment are presented and discussed under the following subheadings:

Population of leaf roller on different varieties of mungbean at different DAS: Mean number of leaf roller per square meter was recorded in different mungbean varieties at different days after sowing (DAS) and is presented in Table 1. At 23 DAS, the highest number of leaf roller/m^2 was observed in the variety BARI Mung-5 (1.96), which was statistically similar BARI Mung-2 (1.95). The second highest number was recorded in BINA Mung-2 (1.86) followed by IPSA Mung-5 (1.86), IPSA Mung-12 (1.86) and BU Mung-2 (1.76). IPSA Mung-5 was statistically identical with IPSA Mung- 12. However, the lowest number of leaf roller was observed in the variety BARI Mung- 6 (1.18) followed by local mung (1.47), BU Mung-1 (1.66) and GK Mung-27 (1.68).

At 30 DAS, the highest number of leaf roller/m^2 was observed in the variety BARI Mung-2 (6.67) which was statistically similar to local Mung (6.67). The second highest number was recorded in IPSA Mung-5 (6.33) followed by BU Mung-2 (6.0), BARI Mung-5 (5.67), BINA Mung-2 (5.33) and IPSA Mung-12 (5.0). Likewise, variety of BINA Mung-2 (5.33) was statistically similar with variety of IPSA Mung-12 (5.0) in respect of leaf roller population (Table 3). However, the lowest number of leaf roller was observed in the variety BARI Mung-6 (3.00) followed by BU Mung-1 (3.67) and GK Mung-27 (4.33).

At 37 DAS, significantly the highest population of leaf roller (7.67) was recorded in the variety BINA Mung-2. Local mung and IPSA Mung-5 were statistically identical with BINA Mung-2. The second highest number was recorded in IPSA Mung-5 (7.0) followed by local Mung (7.0), BU Mung-2 (6.67), BARI Mung-5 (6.0), IPSA Mung-12 (6.0) and BU Mung-1 (5.67). Likewise, variety of BARI Mung-2 (7.67) was statistically similar with variety of local Mung (7.0) in respect of leaf roller population (Table 1). BARI Mung-5 was statistically identical with IPSA Mung-12. However, the lowest number of leaf roller was found in the variety BARI Mung-6 (4.33) followed by BARI Mung-2 (4.67) and GK Mung-27(4.67). In addition, BARI Mung-2 was statistically identical with GK Mung-27.

At 44 DAS, the highest number of leaf roller/m^2 was observed in the variety local mung (2.04). The second highest number was recorded in BINA Mung-2 (1.86) which was statistically similar to BARI Mung-5 (1.86), IPSA Mung-12(1.86), GK Mung-27(1.86) followed by BARI Mung-2 (1.65) and IPSA Mung-5 (1.49). However, the lowest number of leaf roller was observed in the variety BU Mung-2 (1.18) followed by BARI Mung-6 (1.35) and BU Mung-1 (1.38) (Table 1).

From the mean of all varieties regarding leaf roller population it was evident that the variety, local Mung, IPSA Mung-5, BU Mung-2 and BINA Mung-2 had highest population of leaf roller, which indicated that these varieties were highly susceptible to leaf roller. On the other hand, the varieties, BARI Mung-2, GK Mung-27, BU Mung-1 and IPSA Mung-12 had lowest population of leaf roller, which indicated that these varieties were least susceptible to leaf roller. Among all tested varieties, none showed complete resistance against leaf rollers. However, BARI Mung-5 and BARI Mung-6 showed comparatively better resistance against leaf roller.

Table 1. Leaf roller population on different varieties of mungbean at different DAS.

Varieties name	Number of leaf roller/m^2 at days after sowing (DAS)				Mean
	23 DAS	30 DAS	37 DAS	44 DAS	
BARI Mung-2	1.95	6.67	4.67 cd	1.65	3.74 ab
GK Mung-27	1.68	4.33	4.67 cd	1.86	3.13 bc
BINA Mung-2	1.86	5.33	7.67 ab	1.86	4.17 ab
IPSA Mung-5	1.86	6.33	7.00 ab	1.49	4.17 ab
IPSA Mung-12	1.86	5.00	6.00 bcd	1.86	3.68 abc
BU Mung-1	1.66	3.67	5.67 bcd	1.38	3.09 bc
BU Mung-2	1.76	6.00	6.67 bc	1.18	3.90 ab
BARI Mung-5	1.96	5.67	6.00 bcd	1.86	3.87 ab
Local Mung	1.47	6.67	7.00 ab	2.04	4.30 ab
BARI Mung-6	1.18	3.00	4.33 d	1.35	2.46 c
Level of significance	NS	NS	**	NS	*
CV (%)	16.07	34.49	20.56	22.35	23.19

* Significant at 5 % level, ** Significant at 1 % level, NS- Non significant.

Means within column followed by the same letter are not significantly different from one another by CD (critical difference) values. Values are average of three replications.

Seasonal incidence of leaf roller on mungbean: The incidence of leaf roller varied significantly throughout the growing season which was shown in Figure 1. Leaf roller appeared in 16th February, 2016 (2nd week after germination) and population increasing gradually and reached its peak on fourth week (1st March, 2016) from declined with the progress of time. Local mungbean variety is most susceptible to leaf roller. Such incidence of leaf roller on mungbean varieties is agreement with the findngs of Nath *et al.* (1998), who reported that leaf roller was a major pest of mungbean and appeared at the vegetative stage and continued to infest the crop until the pos-reproductive stage.

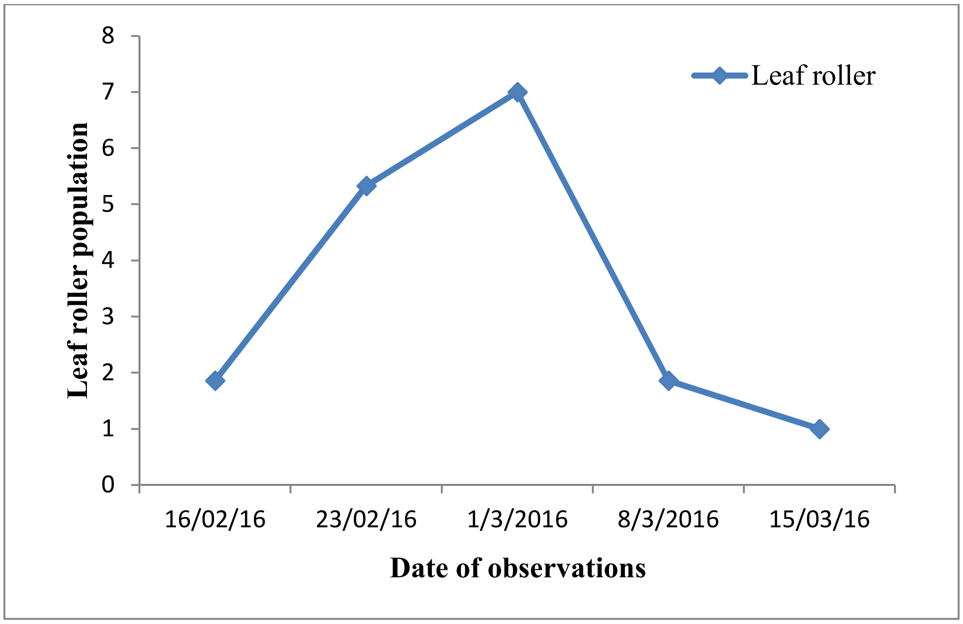

Fig 1. Seasonal abundance of leaf roller on mungbean at various dates of observation

Damage severity by leaf roller: Mean leaf area damaged by flea beetle on different mungbean varieties at different days after sowing is presented in Table 2. At 23 DAS, among the varieties, significantly the highest percent leaf area damage (10.33%) was recorded from the variety BARI Mung-6. The second highest percent leaf area damage was recorded in BU Mung-2 (9.67%) which was statistically similar with BINA Mung-2 (9.33%) followed by IPSA Mung-5 (8.00%), BU Mung-1 (8.0%), local Mung (6.00%) and IPSA Mung-5 (5.67%). IPSA Mung-5 (8.00%) was statistically similar with BU Mung-1 (8.0%). Also local Mung (6.00%) was statistically similar with IPSA Mung-5 (5.67%). However, the lowest percent leaf area damage (4.0%) was found in the variety of BARI Mung-5 followed by BARI Mung-2 (4.67%) and GK Mung-27 (4.67%).

At 30 DAS, among the varieties, significantly the highest percent leaf area damage (16.0%) was recorded from the variety BINA Mung-6. The second highest percent leaf area damage was recorded in IPSA Mung-12(15.67%) followed by IPSA Mung-5 (15.0%), BINA Mung-2 (14.00%), BARI Mung-2 (13.33%), GK Mung-27 (13.33%) and (13.33%). BARI Mung-2 and GK Mung-27 were statistically identical with local mung. However, the lowest percent leaf area damage (12.33%) was found in the variety of BU

Mung-1 followed by BU Mung-2 (10.0%) and BARI Mung-5 (12.33%) and BU Mung-2 (12.33%). BU Mung-2 and BARI Mung-5 were statistically identical with BU Mung-2.

At 37 DAS, among the varieties, significantly the highest percent leaf area damage (24.00%) was recorded from the variety of local Mung. The second highest percent leaf area damage was recorded in BINA Mung-2 (23.67%) followed by IPSA Mung-5 (22.67%), IPSA Mung-12 (22.67%), BARI Mung-6 (22.67%), GK Mung-27 (22.00%), BARI Mung-5 (22.00%). BINA Mung-2 (23.67%), IPSA Mung-5 (22.67%), IPSA Mung-12 (22.67%), BARI Mung-6 (22.67%), GK Mung-27 (22.00%) and BARI Mung-5 (22.00%) ware statistically similar with local Mung (24.00%). However, the lowest percent leaf area damage (14.00%) was found in the variety of BU Mung-1 followed by BU Mung-2 (18.00%) and BARI Mung-2 (18.00%).

At 44 DAS, among the varieties, significantly the highest percent leaf area damage (24.67%) was recorded from the variety BARI Mung-6. The second highest percent leaf area damage was recorded in local Mung-2 (24.33%), followed by BINA Mung-2 (24.00%), IPSA Mung-5 (23.33%), IPSA Mung-12 (23.00%), GK Mung-27 (22.33%) and BARI Mung-5 (22.00%). However, the lowest percent leaf area damage (19.67%) was found in the variety of BU Mung-2 followed by BARI Mung-2 (20.00%) and BU Mung-1 (21.00%) (Table 2).

From the average mean leaf area damage of all varieties, it was evident that the variety of BARI Mung-6, BINA Mung-2, BU Mung-1 and local Mung had highest damage leaf area by leaf roller, which indicated that these variety were highly leaf area damage by leaf roller. On the other hand, the varieties, IPSA Mung-5, GK Mung-27, BARI Mung-5 and BU Mung-2 had leaf area damage by leaf roller which indicated that these varieties had marginal leaf area damage by leaf roller. Among all tested varieties, none showed complete absence of leaf area damage by leaf roller. However, IPSA Mung-12 and BARI Mung-2 showed comparatively less leaf area damage by leaf roller. From the results of table 2, it was evident that the percent leaf area damage by leaf roller increasing due to the age of plant availability of maximum number of leaves in plant.

*Damage of Leaf roller***:** Larvae fold the leaves longitudinally by stitching the leaf margins and eat the green surface. A band was formed due to fusion of individual spun threads and the desiccation of the band facilitates contraction of silk stitches, hence, the leaf rolls. Once protected, the larvae scrape and feed on the green tissues (the mesophyll layer) of the leaves, resulting in the appearance of linear, pale-white stripe damage. In severe infestations, damaged leaves dry up or even plant may die (Verma and Saxena, 1987).

Table 2. Damaged severity of leaf roller attacking mungbean in different dates of observation

Varieties Name	% Damaged leaf area by leaf roller/plant at days after sowing (DAS)				Mean
	23 DAS	30 DAS	37 DAS	44 DAS	
BARI Mung-2	4.67c	13.33cd	18.00b	20.00	14.00e
GK Mung-27	4.67c	13.33cd	22.00a	22.33	15.59bcde
BINA Mung-2	9.33a	14.00bcd	23.67a	24.00	17.75ab
IPSA Mung-5	5.67bc	15.00abc	22.67a	23.33	16.59abcd
IPSA Mung-12	8.00ab	15.67ab	22.67a	23.00	13.835e
BU Mung-1	8.00ab	12.33d	14.00c	21.00	17.34abc
BU Mung-2	9.67a	12.33d	18.00b	19.67	14.92cde
BARI Mung-5	4.000c	12.33d	22.00a	22.00	15.09bcde
Local Mung	6.00bc	13.33cd	24.00a	24.33	16.92abc
BARI Mung-6	10.33a	16.00a	22.67a	24.67	18.42a
Level of significance	**	**	**	NS	*
CV (%)	23.83	8.36	7.26	8.63	11.70

* Significant at 5 % level, ** Significant at 1 % level, NS- Non significant

Means within column followed by the same letter are not significantly different from one another by CD (critical difference) values. Values are average of three replications.

Fluctuation of leaf roller with weather parameters on IPSA Mung-5: Figure 2 illustrates the population of leaf roller insect pests was gradually increased with weather parameters on highly susceptible variety (IPSA Mung-5) of mungbean. The infestation of leaf roller started in the 4th week of February and it was reached maximum in the 2nd week of March at active vegetative stage. Then decreased gradually and reached to zero at 4th week of March. The prevailing temperature and relative humidity were 33-34^{0}C and 96-98% at the peak population period (Figure 2). The highest population of leaf roller (7.0) in per square meter plants in the field was observed in the 2nd week of March and then declined gradually up to the 4th week of March in 2016 (Figure 2).

Relationship between leaf roller population and yield: The result revealed that there was a strong negative correlation between number of leaf roller and yield. It indicated that with the increase of leaf roller there was progressive fall in the yield. A linear regression was fitted between leaf roller abundance and yield (Figure 3). The correlation coefficient (r) was 0.95 and the contribution of the regression (R^2 = 0.9206, when Y= -52.613x + 935.53) was 92.06%.

Plate 1. Damage symptom by leaf roller on mungbean leaf.

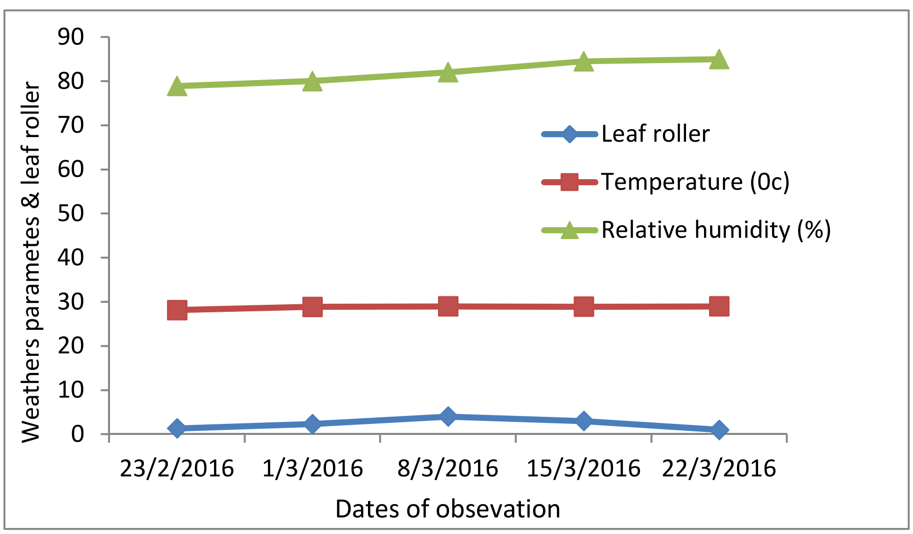

Fig 2. Trend in population fluctuation of leaf roller with mean temperature (°C), mean relative humidity (%) and rainfall (mm) on highly susceptible variety IPSA Mung- 5 of mungbean.

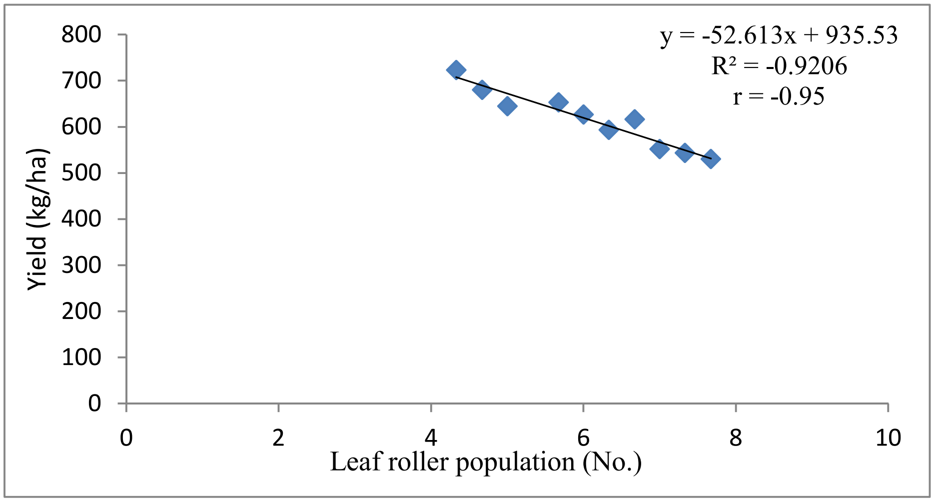

Fig 3. Relationship between leaf roller population and yield of different mungbean varieties.

The findings of the present study are in agreement with the results of Biswas and Islam (2012) who found that Leaf roller infestation was observed in the 3rd week of January at the vegetative and flowering stages (45-60 days after sowing=DAS) of the crop and continued up to pre-maturity period (80-85 DAS). The highest leaf roller population (0.9 and 1.00/plant in 2008 and 2009, respectively) and infestation (90% plant in 2008 and 95% plant in 2009) were recorded in the last week of February at the pod formation stage of the crop (65-70 DAS). Hunt *et al.* (1995) showed mean consumption of mungbean leaf by leaf roller was 0-31 cm^2 d^{-1} and final estimated tissue loss caused by one insects feeding at vegetative stage (14 days) was 13.93 cm^2. Mungbean leaf roller is a polyphagous insect (Alam *et al.* 1964, Correa *et al.* 1987, Hill 1987) but Gazzani (1983) found that the mungbean leaf roller is considered to a secondary pest. It damaged the leaves by eating the leaves without vein. Gowda and Kaul (1982) showed that the leaf roller/folder larvae caused damage by folding and rolling the leaves and web them together. A larva then feed inside on young leaves and buds. Newly hatched larvae weave a white web sticking two adjacent leaflets together or roll up a single or several adjacent leaflets to form cartridges within which they develop.

Conclusion

It is concluded that GK Mung- 27 and BARI Mung- 5 varieties are comparatively better tolerant against leaf roller of mungbean.

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