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EVALUATION OF YIELD AND YIELD COMPONENTS OF EGGPLANT (*Solanum melongena* L.) GENOTYPES IN THE TERAI REGION OF NEPAL

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Abstract

The productivity of eggplant in Nepal is very low due to lack of high yielding, disease and pests resistant varieties. Eight eggplant genotypes [Parwanipur Selection -1 (PS-1), Pusa Purple Long (PPL), Pokhara Lurki, Lalgulab, Pusa Kranti, Arka Keshav, HRDBRI-012 and HRDBRI-013] were evaluated at on-station research field of Regional Agricultural Research Station, Parwanipur, Bara, and PS -1, PPL, Pokhara Lurki, Lalgulab, Pusa Kranti, and Arka Keshav were evaluated at farmers' field, Bara and Parsa districts from 2018 to 2019. Results of the on-station experiment showed that genotype PS-1 was the earliest maturing genotype and was harvested at 56 days after transplanting. The number of fruits per plot (9 m^2 area) was 189 in Arka Keshav followed by HRDBRI-012 (180) and PS-1 (179). The number of marketable fruits per plot (9 m^2) was highest in Lalgulab (166) followed by PS-1 (152). The biggest fruit size was recorded in PS-1 (130 g) followed by Pusa Kranti (121 g) and PPL (108 g). The fruit yield was recorded the highest in PS-1 (25.8 mt/ha). The genotype PS-1 was found more resistant to *Fusarium* wilt and shoot and fruit borer followed by PPL. In farmers field, the highest marketable fruits per plot were produced from PPL followed by Pusa Kranti and PS-1. Similarly, the highest yield and marketable yield were also recorded in PS-1 followed by Pusa Kranti. The genotypes PS-1 and PPL were superior in terms of yield and resistance to disease and pests. Therefore, they could be promising genotypes for central Terai region of Nepal.

Keywords: Eggplant, PS-1, Yield, Genotype, Terai region.

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1. Introduction

Eggplant (*Solanum melongena* L.) is an important solanaceous crop of tropics and sub-tropics. It is native to southern India and widely grown in America, Europe, and Asia including Nepal (Achhami et al., 2013). It is one of the most common, popular, and principal vegetables grown throughout the country except for higher altitude. It is a versatile crop adapting to different agro-climatic regions and can be grown in winter in the Terai region and summer in mid-hills to high hills (Joshi, 2003; Thapa et al., 2009). It is a perennial but grown commercially as an annual crop (Joshi, 2003). This vegetable is available throughout the year in the Nepalese market. The area, production, and productivity of eggplant in Nepal is 8,544 ha, 124,795 mt and 15.0 mt/ha, respectively (MoALD, 2018). In the western Terai conditions, the productivity was 43.15 mt/ha in the genotype Pokhara Lurki (Rawal et al., 2014). The productivity of eggplant in India is 17.4 mt/ha, Asia is 29.0 mt/ha and the world is 29.4 mt/ha, respectively (FAOSTAT, 2018).

The productivity of eggplant in Nepal is low. The low yield is mainly due to the lack of suitable cultivars of field tolerance with many pests and diseases (Joshi, 2003; Thapa et al., 2009). Shoot and fruit borer (*Leucinodes orbonalis*) is one of the significant pests of eggplant (Thapa et al., 2009). The *Fusarium* wilt is one of the most destructive soil-borne fungal diseases of eggplant. The pathogen invades eggplant through roots and proliferates in the vascular tissue, causing a vascular wilt disease (Ganopoulos et al., 2016). There is complete breakdown of the plant, initially through wilting of lower leaves and later of upper ones. The best way to manage this problem is to develop and use resistant cultivars (Boyaci et al., 2012). Officially released an open-pollinated variety of brinjal; namely, 'Nurki' is not successful in meeting the various changing needs of growers and consumers. The Nurki has also not maintained appropriately resulting in degeneration in their original characters. Besides, Nurki is also likely to break down its performance due to many biotic and abiotic stresses. Parwanipur Selection-1 was developed by a pure line selection method and is cultivated in the central Terai region of Nepal (Chaudhary et al., 2004). It contains less number of seed but contains high flesh, and therefore it is highly preferred by consumers in the Terai region. It is used in various recipes in Terai society mainly pakauda, taruwa, chatney, vatuwa etc. The fruit shape and size is preferred by the consumers. The objective of this study was to evaluate and select potential eggplant genotypes suitable for cultivation in the central Terai region of Nepal. Further, we identified high yielding and disease and pest resistant eggplant genotypes suitable for the central Terai region of Nepal. We hypothesized that Parwanipur Selection-1 would be one of the best selections of eggplant and performs similar or better than the exotic genotypes. Further, we hypothesized genotypic variation exists among eggplant genotypes for yield and biotic stress tolerance.

2. Materials and Methods

2.1. Site characteristics

The experiment was conducted at Regional Agricultural Research Station (RARS), Parwanipur, Bara, Nepal from September 2018 to April 2019. The RARS is situated between 84° 15' to 86° 15' east longitude and 26° 15' to 26° 45' north latitude with the elevation of 115 m-asl having subtropical climate (RARS, 2018). The meteorological data for cropping season was recorded from the meteorological station of RARS, Parwanipur, Bara, Nepal. The average maximum and minimum mean daily temperatures were 29.8°C and 19.6°C, respectively. Similarly average relative humidity was 50.4% and mean rainfall was 35.5 mm during the growing period. The soil structure was angular blocky, dark grayish brown (10YR 4/2) in color, silt loam in texture. The soil was moderately acidic in pH (5.67±0.09) and low in organic matter (0.74±0.04%) (Khadka, et al., 2018).

2.2. Experimental details

The experiment was carried out in a randomized complete block design (RCBD) with three replications. Two sets of experiments, on station and farmer's field trials, were carried out. There were eight genotypes tested for yield and yield attributing characters at on-station. These genotypes were as follows.

1. Parwanipur Selection -1 (PS-1)
2. Pusa Purple Long (PPL)
3. Pokhara Lurki
4. Lalgulab
5. Pusa Kranti
6. Arka Keshav
7. HRDBRI-012
8. HRDBRI-013

These genotypes were selected to evaluate because of their adoption in the tropical region and popular among growers conditions.

The plot size was 6 m x 1.5 m (9 m^2), with planting distance of 75 cm x 60 cm. There were 10 plants per row and two rows per experimental unit. Therefore, in total there were 20 plants per plot per treatment. The seeding was done in September and 25 days old seedlings were transplanted in October 2018. Farmyard manure (FYM) was applied @ 100 kg per plot (basal) (5 kg per plant), urea @ 600 g per plot (half as basal) and two split doses for top dressing at 30 days after transplanting (DAT) and 60 DAT (15 g per plant x 20 plants per plot @300 g per plot as basal dose). Diammonium phosphate (DAP) was applied @ 400 g per plot (basal) (20 g x 20 plants per plot @400 g per plot) and muriate of potash (MOP) was applied @ 200 g per plot (basal) (10 g x 20 plants per plot @200 g per plot. Larva Plus, a biopesticide was received from ATC Scientific Business Conservation Center (Seeds Center), Lagankhel, Lalitpur, Nepal. It is manufactured by Greenland Bioscience and marketed by Asha Bio Crop Care, Haryana, India. Plant protection measures were done regularly by spraying organic pesticide 'Larva Plus', sourced from ATC Scientific Business Conservation Center (Seeds Center), Lagankhel, Lalitpur, Nepal every ten days interval to protect from the shoot and fruit borer attack. The Lucin Lure in WOTA-T trap, sourced from ATC Scientific Business Conservation Center (Seeds Center), Lagankhel, Lalitpur, Nepal (2 traps per Kattha, where 30 kattha =1 hectare) was installed and Lucin Lure was changed every 60 days. The Wota-T traps consisted of a hood to hold pheromone lure and a tray where soapy water was kept.

In a farmer's field, the experiment was carried out in two farmer's fields namely Ram Nagari, Parsa and Tetariya, Bara districts in RCBD design with three replications. There were six genotypes of eggplant evaluated for yield and yield attributing characters at farmer's field conditions. These genotypes were as follows.

1. Parwanipur Selection -1 (PS-1)
2. Pusa Purple Long (PPL)
3. PokharaLurki
4. Lalgulab
5. Pusa Kranti
6. Arka Keshav

These genotypes were selected to evaluate because of their adoption in the region and popular among growers conditions. The two genotypes namely HRDBRI-012 and HRDBRI-013 were not included for evaluation at farmers field because they were newly introduced exotic germplasm and needed to evaluate at station before evaluation at the farmers field conditions.

The plot size was 6 m x 2.25 m (13.5 m^2), with planting distance 75 cm x 60 cm. There were ten plants per row and three rows per treatment. Therefore, there were 30 plants per plot per treatment. Fertilizer was applied as FYM: 100 kg per plot (basal) (5 kg per plant), urea: 600 g per plot (half as basal) and two split doses for top dressing at 30 DAT and 60 DAT (15 g per plant x 30 plants per plot = 450 g per plot as basal dose). DAP was applied @600 g per plot (basal) (20 g x 30 plants per plot = 600 g per plot) and MOP was applied @300 g per plot (basal) (10 g x 30 plants per plot = 300 g per plot). Plant protection measures were done regularly by spraying organic pesticide 'Larva Plus' every 15 days interval based on manufactures guidelines. The Lucin Lure in WOTA T trap (one trap per site) (Wota-T® Trap) was installed.

2.3. Parameters observed

Plant vigor

The relative degree of foliage mass of a genotype is plant vigor. Vigor was recorded at about 50% flowering stage using a 1 to 5 rating scale according to the method described by Gotame et al. (2019) as follows.

1= Poor (all plants are small, few leaves, week plants, very thin stems, and light green color)

2 = Week (75% of the plants are small or all plants are shorter than average plant height, plants have few leaves, thin stem and light green color)

3= Medium (the intermediate or average growth)

4= Vigorous (75% of the plants are taller than average, robust with foliage of dark green color, thick stems, and leaves are well developed)

5= Excellent (all plants are taller than average, ground entirely covered by foliage, plants are robust, with a thick stem and abundant foliage of dark green color)

Fusarium wilt (Fusarium oxysporum f. sp. melongenae) score

The disease was scored during flowering and at peak harvesting time. The number of wilted plants (plants showing symptoms) against the total number of plants per plot was recorded. Scoring was done using a 1-5 scale as described by Dinssa et al. (2015) and Gotame et al. (2019) as follows.

Plant status	Score (1-5)
Healthy plants	= 1
About 25% of the plants wilt	= 2
About 50% of the plants wilt	= 3
About 75% of the plants wilt	= 4
The entire plant wilt	= 5

Shoot and fruit borer infestation score

The number of infested plants with the shoot and fruit borer (plants showing symptoms) against the total number of plants per the plot, were recorded according to the method described by Thapa et al. (2009) and Awal et al. (2017).

$$\text{Percent of fruit infestation by number} = \frac{\text{Number of fruits infested } \times 100}{\text{Total number of fruit harvested}}$$

Fruit status	Score (1-5)
Healthy fruits (0% infestation)	= 1
1-25% of the fruit infested	= 2
26-50% of the fruit infested	= 3
51-75% of the fruit infested	= 4
76-100% of the fruit infested	= 5

2.4. Statistical analysis

The experimental data were processed by using MS Excel 2016 and analyzed by using Genstat var. 18.0 (GenStat). Two-way ANOVA was used to analyze the difference between the means observed parameters on yield and yield attributing characters, and disease and pests score (Gomez and Gomez, 1984). Normality was checked using histogram before analysis.

3. Results and Discussion

3.1. Growth parameters

Plant height is considered as one of the important traits for growth and vigor of the plants. In the present study, significant differences were recorded in plant height in eggplant genotypes (Table 1). The highest plant height was found in Pusa Purple Long (73 cm) which was followed by Parwanipur Selection-1 (71 cm). Plant height is a quantitative trait, where variation is continuous and often is controlled by several genes, each having a minor effect. Plant height can be influenced greatly by genotype and environment. The reason for higher in plant height in PPL and PS-1 could be due to the genetic variations exits in the eggplant genotypes. These findings are in agreement with that of Mohanty et al. (2001) who reported the greatest plant height found in BB-11 followed by Bhawanipatna Local and Black Beauty. Similarly, Rai et al. (1998) reported the differences in plant height among varieties/hybrids of eggplant put under evaluation and screening trials. The genotypic variance for days to first picking was significant for eggplant genotype (Table 1). Parwanipur Selection-1 was the earliest genotype and first fruit harvesting was done at 56 days after transplanting (DAT). The second earlier cultivar was Pusa Kranti which produced the fruit ready for harvesting at 60 DAT followed by PPL. The number of flowers per cluster was found the highest in Arka Keshav but was non-significant between genotypes (Table 1).

Table 1: Performance of eggplant genotypes at on-station research field of RARS, Parwanipur, Bara, Nepal, 2018 /19

Genotypes	No. plant per plot	Plant height cm	No. of flower per cluster	No. of fruits per cluster	% fruit set	Days to first picking (DAT)	No. of fruit per plot	Adjusted No. of fruits per plot
Parwanipur Selection -1	19	71	8	6	75	56	170	179
Pusa Purple Long	18	73	7	6	86	64	151	168
Pokhara Lurki	19	65	8	6	75	70	159	167
Lalgulab	16	63	5	5	100	65	135	169
Pusa Kranti	20	60	6	6	100	60	138	138
Arka Keshav	19	54	9	7	78	90	180	189
HRDBRI-012	5	70	7	7	100	70	45	180
HRDBRI-013	5	68	6	6	100	73	39	156
SEm±	6.36	6.35	1.31	0.64	12.03	10.34	54.66	13.55
F test		*	ns	ns	ns	*		*
CV %		12	36	20	10	14	17	11

*** Highly significant difference at 0.01 level of significance, SEm±: Standard error of mean, CV: Coefficient of variation, DAT= Days after transplanting.*

3.2. Yield and yield attributing traits

In the present study, we found there were significant differences in yield and yield attributing traits among the tested genotypes. The number of fruits per cluster were found the highest in Arka Keshav but were non-significant between genotypes. The adjusted number of fruits per plot (9 m^2 area) was 189 in Arka Keshav followed by HRDBRI-012 (180) and Parwanipur Selection-1 (179) respectively (Table 1). Yield is also a quantitative character governed by many genes and is largely affected by environmental conditions. In the present study data regarding the number of fruits per cluster showed differences among the genotypes. The genotypic differences always play an important role in the determination of yield. The results are in concordance with those of Prabhu et al. (2008) and Dharwad et al. (2009) who reported variation in fruit yield of eggplant in their experiments. When evaluating eggplant genotypes for their economic traits like branches per plant, fruit girth, many fruits per plant and fruit weight, they found that these traits played a major role and recommended to consider in selection program for improvement of yield potential of eggplant (Prabhu et al., 2008).

3.3. Fruit weight, marketable yield, and adjusted yield

The yield being a polygenic trait is a result of component characters like the number of fruits per plant and fruit weight. Our study showed that the number of marketable fruits per plot (9 m^2 area) was recorded the highest in Lalgulab (166) which followed Parwanipur Selection-1 (152). The HRDBRI-012 produced the lowest marketable fruits (70 per plot). Fruit size was the highest in Parwanipur Selection-1 (130 g) followed by Pusa Kranti (121 g). The highest fruit size produced in PS-1 could be a genetically inherent character of the genotype. The results are in concordance with those of Jirankali et al. (2019) and Praneetha (2002) who observed variation among eggplant genotypes for marketable fruit yield. Eggplant germplasms have large genetic variation for agro-morphological characteristics including vegetative, yield, and yield components among the 29 accessions (Sulaiman et al., 2020). The adjusted fruit yield was found the highest in Parwanipur Selection-1 (23.3 kg per plot and 25.8 mt/ha) followed by PPL (18.1 kg per plot and 20.1 mt/ha) which is promising in the central Terai conditions of Nepal (Table 2). In contrast, Rawal et al. (2014) found that Pokhara Lurki produced the highest yield (43.1 mt/ha) at western Nepalgunj conditions. Gogoi et al. (2018) has also reported that the local eggplant genotypes JC-1 and Longai exhibited moderately resistant reaction to abiotic stress and also found superior in respect to total fruit yield at Assam, India conditions. Studies reported that indigenous selections of horticulture species performed best over exotic varieties (Gotame et al., 2014).

Table 2: Yield (metric tonne, mt) and yield components of eggplant genotypes at on-station research field of RARS, Parwanipur, Bara, Nepal, 2018 /19

Genotypes	No. of marketable fruit per plot	Fruit yield per plot kg	Adjusted fruit yield per plot kg	Adjusted yield mt /ha
Parwanipur Selection -1	152	22.1	23.3	25.8
Pusa Purple Long	122	16.3	18.1	20.1
Pokhara Lurki	144	15.6	16.4	18.2
Lalgulab	166	11.6	14.5	16.1
Pusa Kranti	138	16.7	16.7	18.6
Arka Keshav	144	10.1	10.6	11.8
HRDBRI-012	70	4.4	17.6	19.6
HRDBRI-013	89	4.0	16.1	17.9
SEm±	12.682	2.227	1.256	1.395
F test	**	**	**	**
CV %	28	34	20	17

*** Highly significant difference at 0.01 level of significance, SEm±: Standard error of mean, CV: Coefficient of variation.*

Table 3: Shape, size and color of eggplant genotypes at on-station research field of RARS, Parwanipur, Bara, Nepal, 2018 /19

Genotypes	Fruit weight g	Fruit length cm	Shape	Color
Parwanipur Selection -1	130	20.2	Long	Stripe purple
Pusa Purple Long	108	21.0	Long	Dark purple
Pokhara Lurki	98	26.9	Long	Purple
Lalgulab	86	18.3	ovate	Light purple
Pusa Kranti	121	14.2	Ovate	Purple
Arka Keshav	56	15.7	Ovate	Green
HRDBRI-012	98	14.8	Ovate	Purple
HRDBRI-013	103	14.6	Ovate	Purple
SEm±	7.967	3.5		
F test	**	*		
CV %	39	13		

*** Highly significant difference at 0.01 level of significance, SEm±: Standard error of mean,CV: Coefficient of variation.*

3.4. Plant vigor, disease and pests resistant

Plant vigor and *Fusarium* wilt score were not significantly different between genotypes. However, it was found that Parwanipur Selection-1and Pusa Purple Long was the vigorous genotypes. Both cultivars were very vigorous the tallest (71 cm and 73 cm high respectively, Table 1). Arka Keshav was the least vigorous. The production of eggplant has been hindered by several insect pests and devastating diseases. There was no significant differences in *Fusarium* wilt resistant among the genotypes. Fruit and shoot borer is one of the most serious pests in eggplant. Arka Keshav and Pusa Kranti were the most susceptible cultivars with the shoot and fruit borer (Table 4). Breakdown of insect resistance in these genotypes may be due to climatic factors which was more congenial for insect severity. There was increasing in temperature as before maturing and fruit harvesting days in Arka Keshav and Pusa Kranti which were late maturing genotypes. Therefore, even though organic pesticide ' Larva Plus' was applied, fruits were infested by shoot and fruit borer. It was reported that the percent of shoot and fruit borer infested fruits in eggplant was increased with increasing temperature (Koundinya et al., 2019).

The insect severity varies with the genetic makeup of eggplant genotypes. In contrast to our findings, Rawal et al. (2014) found that the highest insect infestation in PS-1. Thapa et al. (2009) reported that there were average of 60% infection in PPL and 64% in PS-1 in two consecutive seasons at RARS, Parwanipur conditions. Koundinya et al. (2019) mentioned that there was negative correlation between genotypes with spines on stem but positive correlation with petiole and pigmentation on leaf lamina, purple color flowers/fruits and shoot and fruit borer infestation. The long slender fruit shape and clustered fruiting habit also promoted the shoot and fruit borer infestation (Thapa et al. 2009; Koundinya et al., 2019).

Table 4: Performance of eggplant genotypes at on-station research field of RARS, Parwanipur, Bara, Nepal, 2018 /19

Genotypes	Plant vigor (1-5 scale)	Shoot and fruit borer infestation (1-5 score)	*Fusarium* wilt score (1-5 score)
Parwanipur Selection -1	5	1	1
Pusa Purple Long	5	1	2
Pokhara Lurki	4	3	1
Lalgulab	3.5	2	2
Pusa Kranti	4.5	4	1
Arka Keshav	3	4	3
HRDBRI-012	4.5	3	1
HRDBRI-013	4.5	3	1
SEm±	0.25	0.42	0.26
F test	ns	*	ns
CV %	45	23	18

**Significant difference at 0.05 level of significance, ns: Non-significant, SEm±: Standard error of mean, CV: Coefficient of variation.*

3.5. Yield performance of eggplant genotypes at farmer's field

Yield, a complex character, is governed by a large number of factors viz genotype, environment and management. Yield in each genotype is a result of the cumulative effect of different yield attributing characters. The results from the farmer's field trial (FFT) revealed that an adjusted number of fruit per plot was the highest in Pusa Purple Long (356) followed by Lalgulab (337) and Pusa Kranti (308). Similarly, the highest marketable fruit per plot was produced from Pusa Purple Long followed by Pusa Kranti and Parwanipur Selection-1. Arka Keshav produced the lowest number of fruits (178) per plot. The largest fruit size was found in Parwanipur Selection-1 (165 g) followed by Pusa Kranti (139 g) and Pusa Purple Long (108 g). Similarly, the highest yield, marketable yield and adjusted yield was also found highest from Parwanipur Selection followed by Pusa Kranti (Table 5). The genotypic differences always play an important role in the determination of yield contributing characters of the genotype. This result was similar to the finding of Tumbe et al. (1992) who found the yield variation in eggplant genotypes. Chauhan et al. (2016) reported that marketable fruit yield was positively correlated with fruits per plant, plant height and fruit weight in eggplant. It is reported that fruit weight was the most appropriate character for the selection to operate on for obtaining high fruit yield of the biparental population of crosses *viz*., Arka Keshav × Bhola Nath.

Table 5: Performance of eggplant genotypes from two farmers' fields in Bara and Parsa districts, 2018 /19

Genotypes	No. of plant per plot	No. of fruit per plot	Adjusted No. of fruits per plot	No. of marketable fruit per plot	Fruit weight g	Fruit yield per plot kg	Adjusted yield per plot kg	Adjusted yield mt /ha
Parwanipur Selection -1	29	262	271	246	165	43	44.7	33.1
Pusa Purple Long	25	297	356	294	108	32	38.5	28.5
Pokhara Lurki	30	241	241	229	104	25	25.1	18.6
Lalgulab	22	247	337	246	86	21	29.0	21.5
Pusa Kranti	27	277	308	279	139	39	42.8	31.7
Arka Keshav	30	208	208	178	56	12	11.6	8.6
SEm±	1.12	10.91	20.21	14.40	13.59	4.11	4.44	4.94
F test			*	**	**	**	**	**
CV %		17	11	28	39	34	20	17

** Significant difference at 0.05 level of significance, ** Highly significant difference at 0.01 level, SEm±: Standard error of mean, CV: Coefficient of variation.*

Our experiment was carried out in the farmer's field conditions of two locations. There were field variation and was difficult to eliminate. Therefore, the CV was high in most of the significant different traits of the genotypes.

4. Conclusion and recommendations

The present study reported a considerable variability for yield due to variation in yield contributing traits among eggplant genotypes. Of all genotypes, on-station research showed that PS-1 and PPL were the superior genotypes in terms of yield and yield attributing traits. While results from farmers' field trial, PS-1 was found to be more productive and high yielding compared to other established imported and or exotic cultivars. PS-1 showed relatively better resistance to *Fusarium* wilt, and shoot and fruit borer. Therefore PS-1 could be one of the superior and promising genotypes for commercialization at the central Terai region of Nepal. With the limitation of this research, we suggest to evaluate PS-1 for its suitability and farmer's preference in eastern Terai and western Terai region to make its wider recommendation.

Conflict of interest

The authors declare no conflicts of interest.

Authors contribution

T.P. Gotame designed, executed the experiment and wrote the draft of the manuscript, S.L. Shrestha provided materials for research and finalized the manuscript, S.Poudel involved in field layout, genotype evaluation, data collection and J. Shrestha finalized the initial draft of this manuscript.

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References

Awal, A., Rahman, M.M., Alam, M.Z. and Khan, M.M.H., 2017. Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* (Lepidoptera: crambidae) using some selected insecticides in field condition, Bangladesh. Jahangirnagar University J. Biol. Sci. 6(1): 35-43.

Achhami, B.B., Tiwari, S. and Sharma, S., 2013. Survey on brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) in brinjal (*Solanum melongena* L: Solanaceae) growing district of Nepal. Nepalese J. Agri. Sci., 11: 38-44. ISSN 2091-042X.

Boyaci, F., Unlu, A. and Abak, K., 2012. Screening for resistance to *Fusarium* wilt of some cultivated eggplants and wild solanum accessions. Acta Hortic. 935: 23-27 DOI: 10.17660/Acta Hortic.2012.935.2.

Chaudhary, U.L., Ghimire, J. and Sah, R.L., 2004. Development of brinjal genotype for higher yield and wider adaptation. B.B. Khatri, B.P. Sharma, P.P. Khatiwada, K.P. Paudyal, B.R. Khadge, and H.N. Regmi (Eds). Proceeding of the Forth National Workshop on Horticulture, Kathmandu, Nepal.

Chauhan, A., Chandel, K.S. and S. Kumari., 2016. Genetic variability, character association and path analysis for fruit yield components and quality traits in eggplant (*Solanum melongena* L.). Sabrao J. Breeding and Genetics. 48 (4): 536-546.

Dharwad, N.A., Salimath, P.M. and Patil, S.A., 2009. Association and path coefficient analysis in elite germplasm lines of brinjal (*Solanum melongena* L.). Karnataka J. of Agri. Sci., 22 (5):965-966.

Dinssa, F.F., Mbwambo, O., Macharia, J., Aloyce, A., and Shilla, O., 2015. Protocols for fruit, leafy and bulb-type vegetable cultivar testing. AVRDC-The World Vegetable Center. Shanhua, Taiwan. Publication Series 15-793. Pp 6.

FAOSTAT., 2018. Food and Agricultural Organization (FAO). Food and Agricultural Organization Web site: http://www.fao.org/faostat/en/No. of data/QC. Retrieved on August 25, 2019.

Ganopoulos, I., Xanthopoulou, A., Konstantinou, S., Karaoglanidis, G.S., Tsaliki, E., Kalivas, A. and Madesis, P., 2016. Fast and accurate screening of *Solanum melongena* with high-resolution melting analysis for resistance to *Fusarium* wilt. Inter. J. Veg. Sci., 22 (2):183–189. http://dx.doi.org/10.1080/19315260.2014.995330.

Gogoi, S., Mazumder, N. and Talukdar, J., 2018. Evaluation of brinjal varieties for yield, genetic variability and disease reaction grown as late rabi season crop in Assam. Indian J. Agric. Res., 52 (2): 191-194. DOI: 10.18805/IJARe.A-4792.

Gomez, K. A. and Gomez, A. A., 1984. Statistical procedure for agricultural research (2nd Ed.). Int. Rice Res. Inst. And Willey, New York. Pp. 28-192.

Gotame, T.P., Gautam, I.P., Shrestha, S.L. and Pradhan, N.G., 2019. A field guide for vegetable germplasm testing and variety registration/release. Nepal Agricultural Research Council (NARC), National Agriculture Research Institute (NARI), Horticulture Research Division (HRD) Khumaltar, Lalitpur. NARC Publication Serial No. 00669-683 (2019/20).

Gotame, T.P., Paudyal, K.P. and Khatiwada, P.P., 2014. Status of fruit and nut genetic resources in Nepal, indigenous and exotic varietal inventory. Horticulture Research Division, Nepal Agricultural Research Council, Khumaltar, Lalitpur. NARC Publication Serial No. 0090-12 (2013/14).

Jirankali, J.P., Reddy, N., Gangaprasad, S. and Manohara, S.N., 2019. Genetic variability for quantitative and qualitative characters in brinjal (*Solanum melongena* L.). Int. J. Curr. Microbiol. App. Sci. 8(03):476-484.doi: https://doi.org/10.20546/ijcmas.2019.803.060.

Joshi, S.L., 2003. Investigation of eggplant fruit and shoot borer (*Leucinoides orbonalis* Guen) in Nepal. *In:* Proceedig of the Third National Horticulture Research Workshop, 7-8 June 2000. Nepal Agricultural Research Council, Horticulture Research Division, Khumaltar, Lalitpur, Nepal. Pp. 54-60.

Khadka, D., Lamichhane, S., Bhurer, K., Chaudhary, J., Ali, M., and Lakhe, L., 2018. Soil fertility assessment and mapping of Regional Agricultural Research Station, Parwanipur, Bara, Nepal. J. Nepal Agr. Res. Council, 4(1): 33-47. https://doi.org/10.3126/jnarc.v4i1.19688.

Koundinya, A.V.V., Pandit, M.K. and Saha, A., 2019. Association of fruit and shoot borer infestation in eggplant with morphological, yield, quality and external weather variables. Agric. Res. 8, 309–319. https://doi-org.prox.lib.ncsu.edu/10.1007/s40003-018-0380-0.

MoALD., 2018. Statistical information on Nepalese agriculture. Ministry of Agricultural Development. Agri-Business Promotion and Statistics Division, Singh Durbar Kathmandu, Nepal.

Mohanty, B.K., Hossain, M.M. and Prusti, A.M., 2001. Assessment of brinjal cultivars in black soils of Orissa. J. Soils and Crops, 11(1): 33-35.

Prabhu, M., Natrajan, S. and Veeraragavathatham, D., 2008. Correlation and path coefficient analysis in eggplant (*Solanum melongena* L.). Indian J. of Agri. Res., 42(3): 232-234. Praneetha, S., 2002. Correlation studies in brinjal (*Solanum melongena* L.). South Indian Hort., 53 (6): 286-290.

Rai, N., Singh, A.K. and Sarnaik, D.A., 1998. Evaluation of round shaped brinjal varieties for stability of their yield contributing attribute. Veg. Sci., 25(2):136-140.

Rawal, R., KC, Y.P., Gautam, I.P., Khadka, R. and Shrestha, S.L., 2014. Performance of promising brinjal (*Solanum melongena* L.) varieties in mid-western Terai of Nepal. Nepalese J. Agri. Sci., 12: 178-184. ISSN 2091-042X.

RARS., 2018. Annual Report 2074/75 (2017/18). Regional Agricultural Research Station, Parwanipur, Bara, Nepal.

Sridhar,V.,Vijay, O.P. and Naik, G., 2001. Field evaluation of brinjal (Solanum spp L.) germplasm against shoot and fruit borer (*Leucinodes orbonalis* G.). J. Insect Env., 6 (4): 155-156.

Sulaiman, N.N.M., Rafii, M.Y., Duangjit, J., Ramlee, S.I., Phumichai, C., Oladosu, Y., Datta, R.D. and Musa, I., 2020. Genetic variability of eggplant germplasm evaluated under open field and glasshouse cropping conditions. Agronomy 2020, 10: 436; doi: 10. 3390/agronomy10030436.

Thapa, R.B., Achhami, B., Tiwari, S. and Dhakal, S.C., 2009. Field screening of selected brinjal genotypes against shoot and fruit borer in eastern Terai of Nepal. J. Inst. Agri. Anim. Sci., 30:173-177. ISSN. 2091-0134.

Tumbe, T.B., Reme, D.A. and Kale, P.N., 1992. Genetic diversity in brinjal (*Solanum melongena* L.). Maharashtra J. Hort., 6: 61-65.