Host resistance breeding against the virus diseases of soybean in Nepal

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Abstract— *Soybean is a miracle legume crop of Nepal which shares 7% out of total legume production and ranks third position after lentil (MOAD, 2015). Being high nutritious legume crop helps to food & nutritional security and sustainable soil management in the system niches. Soybean is mainly consumed as roasted bean or green pod as vegetable and grown in either rice bund or intercropped with maize in mid hills of Nepal. It has a great potentiality for commercial cultivation in terai/inner terai, as soybean is becoming one of the important ingredient of poultry feed which is well thriving in Nepal. However the national productivity of soybean was very low due to the vulnerable to virus diseases. There is a long list of diseases that infect soybean and many diseases are of soil borne nature and pathogens survive in the soil for a long period of time. MYMV are the important diseases of soybean observed in terai/ inner terai region of Nepal. White fly (BemisiatabaciGenn.) transmitted Mungbean Yellow Mosaic Virus has been a serious threat to blackgram, soybean, mungbean and cowpea production in terai / inner terai and foot hills. Yield losses up to 100%, 52.6% and 21% have been reported due to MYMV in blackgram, mungbean and soybean, respectively. Farmers have been using a variety of fungicides indiscriminately which has serious hazardous effects on environment and human health. Efforts to validate farmers' indigenous knowledge for MYMV management turned futile since no treatment appeared beneficial in susceptible cultivar like Chapbas Local in hot spot location i.e. Rampur. Some genotypes have been observed resistant to MYMV in mungbean while genotypes with durable resistance are scanty in blackgram and soybean. Unavailability of suitable variety for various cropping patterns such as Maize-soybean-toria /other winter crops, Rice+Soybean (Bund Planting) has been realized in the recent years. Released varieties have more or less smaller seed size, susceptible to different foliar diseases Like YMV and longer maturity period (135-145 days), which farmers usually don't prefer. Varietal differences have been observed in its severity. Chemical control measures are not environmentally friendly. Under such situation use of resistant varieties and manipulations in cultivation practices are important options for the management of grain legume diseases. This approach is accessible to marginal and disadvantaged farmers too. In this context, the main objective of the study was to identify high yielding and resistant to yellow mosaic virus diseases tolerant of soybean suited for existing cropping system. MYMV severity is gradually building up at Rampur, Chitwan. High population of white fly (Bemisiatabaci) observed during the crop season. For this, many local landraces and exotic lines received from IITA and AVRDC were evaluated at Rampur. Three years research results (2012-2014) revealed that soybean genotypes CM9125, G8754, LS-77-16-16, SB0065 and SB0095 showed resistant to MYMV and Chaing Maw 60-63, CM9133, Dhankuta and SJ-4 were moderately resistant in physical observation. These genotypes were promoted in participatory trials to validate at the farmers field and seed increase program at farm level of different agro eco-system. Besides legume breeders are being used it as a parent materials in crossing program to develop disease resistant high yielding varieties at the research station.*

Keywords— Soybean, Yellow Mosaic Virus, genotypes, cropping system.

I. INTRODUCTION

A wonderful crop soybean (Glycine max L. Merril, 2n = 40) belongs to Leguminosae family is the third most important grain legume of Nepal in terms of acreage and production after lentil and blackgram. It is widely distributed in the mid hills and to a less extent in the terai& inner terai. In mid hills and valleys it occupies about 80% in terms of total soybean area and production. Soybean can be grown successfully at altitude ranging from 500 to 1500 m amsl (Neupane and Bharati 1990), showing diverse adaptability to varied agro-ecological zones. In mid hill, it is mainly grown as intercrop or mix crop with maize and on paddy bund. It is also relayed with maize in the valleys. It is grown mainly as mixed cropping with minimum inputs which have very much affected its intensification of production especially in mid hills. In recent years, soybean cultivation as mono or relay with maize is slowly gaining popularity in terai and inner terai due to its extensive use as poultry feed. There is a great potential to increase the area and production due to its stable nature of the production and grown in diverse climate from terai to high hills. The demand of soybean is increasing day by day with increase in poultry business in the country as it is important and basic ingredients of poultry feed. Mostly, soybean for feed industries is imported from India. At the same time, Nepal imports huge amount of raw materials of soybean for oil and feed purposes. Since soybean contains cholesterol free oil, which is additional

useful to the heart patients (safer). In the year 2014 alone, soybean crude oil of Nepalese Rupees 12483.2 million (around $120.030 million) was imported from India, Argentina, Brazil and Paraguay (MoAD, 2015). Thus there is high potential of soybean cultivation as a commercial scale in the terai, innerterai and mid hills regions of Nepal. Soybean has high nutritional value for human being as it contains high amount of protein (40-50%), oil (20%), and rich in multi-vitamins and essential minerals. It is reported that locally available black and brown coated soybean landraces are rich in protein while creamy white, yellow coated soybean are rich in oil content. There is possibility of rich oil and protein content imported exotic lines from IITA and IVRDC. It can be used as a good supplemental food with cereal especially in the underdeveloped country where people suffer from mal-nutrition. As a human food soybean seeds are utilized in many ways green pods as vegetables and dry seeds eaten roasted or fried. Soybean oil is used for manufacturing vegetable ghee. Soybean is used to prepare baby food and food for diabetic patients. Soybean cake and meal are utilized for preparing various livestock and poultry feeds. Soybean crop can be used as green manure and as a fodder crop. Particularly for developing country like Nepal where chemical fertilizers are extremely expensive & inclusion of soybean in existing cropping pattern has a substantial benefit both in terms of human health for producing protein rich food and also in improving the soil health. Figureindicated soybean‘s area, production and productivity has been increased trends by 36%, 189% and 115 % respectively in between 1983/84 and 2012/13. The increasing trend of soybean production and productivity was due to the available of technologies, HY varieties, soybean mission and international strong support for genetic materials. However, the national yield of soybean is very low in international level and evener has been slightly increased from 546 (1984/85) to 1180 kg/ha (MOAD, 2015). Contributing low yield of the Nepalese soybean might be due to the disease severity like Yellow Mosaic Virus (YMV), anthracnose/ pod blight (*Colletotrichumtruncatum*), charcoal rot (*Macrophominaphaseolina*) and bacterial pustule (*Xanthomonasphaseolivarsojensis*) in the terai and inner terai while CLS (*Cercosporakikuchii*), anthracnose/ pod blight and BP in the mid hills and frog eye leaf spot (Cercosporasojina) in the high hills are important (NGLRP, 2010).

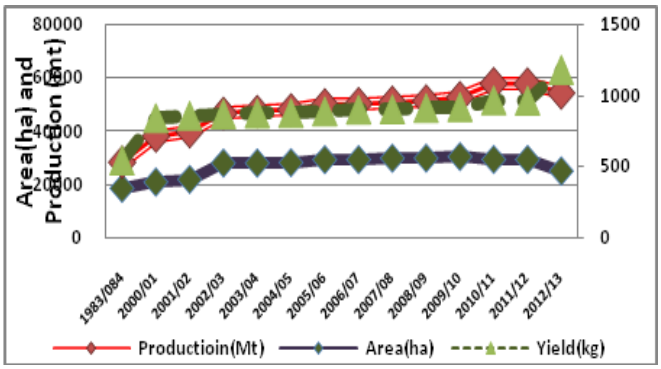

FIG. 1. AREA, PRODUCTION AND PRODUCTIVITY TRENDS OF SOYBEAN OVER THE YEARS(1983-2012) IN NEPAL

- Figure indicated soybean ‘s area, production and productivity has been increased trends by 36%, 189% and 115 % respectively in between 1983/84 and 2012/13
- Imported huge amount of soybean raw materials and oil products (About $ 163.26 million)
- Starts soybean mission in Nepal since 2012

Vector white fly (*Bemisiatabaci* Genn.) is responsible for transmitting *Mungbean Yellow Mosaic Virus* disease has been escalated a serious threat to blackgram, soybean, mungbean and cowpea production in terai/ inner terai and foot hills of Nepal. Yield losses recorded up to 100%, 52.6% and 21% have been reported due to MYMV in blackgram, mungbean and soybean, respectively. Soybean is susceptible to several viruses transmitted by the vectors aphids, beetles and whiteflies prevailing in Nepal. Most of the virus infection results in foliar symptoms such as mosaic and mottling, thickening/brattling of older leaves, puckering, leaf distortion, severe reduction in leaf size, and stunting of plants. Mixed infection with more than one virus is common under field conditions. Mungbean yellow mosaic virus transmitted by whitefly (*Bemisiatabaci Gennidius*) is the most prevalent virus associated with soybean mosaic disease in Nepal. Depending on genotype and age of infection symptoms range from mosaic and mottling, leaf curling, green vein banding, and stunting. Most severe symptoms are observed in plants infected at early stages of growth (pre-flowering) and significant reduction in pods. Soybean yellow mosaic virus was found to be the most prevalent virus associated with this disease. Soybean mottle mosaic virus, which also causes similar symptoms, was found to be less frequent in the fields. Virus-infected plants produce bright yellow mosaic or specks, and develop into large blotches on the leaf lamina, but this infection does not result in leaf distortion or reduction in lamina size. This is the most convenient,

economical, and effective approach for controlling soybean virus diseases. Even though, the maximum yield potential obtained in sole cropping at research station was recorded as high as 3.5 t/ha. Till date Hardee, Cobb, Puja are released for inner terai/terai, while Ransom, Seti, Lumle 1 and Tarkari Bhatmas 1 for Kathmandu valley and similar environments. Released varieties have more or less smaller seed size, susceptible to different foliar diseases like YMV, pod blight, Bacterial pustule, frog eye leaf spot and longer maturity period (135-145 days), which farmers usually don't prefer. The performances of varietal differences have been observed due to its severity. Chemical control measures may have the option but they are not environmentally friendly and healthier. Under such situation use of resistant varieties and manipulations in cultivation practices are important choices for the proper management of grain legume diseases. This approach is accessible to marginal and disadvantaged farmers too. High population of white fly (*Bemisiatabaci*) was observed at the station and on farm level during the crop season in the fiscal year 2012-2014 which was the challenges and opportunity to select the best YMV resistant lines. G x E interaction is the directly associated with the diseases intensifying and depends on the favorable climate to multiply the whitefly. Considering these all facts, the main objective of the study was carried out to identify and select the high yielding and host resistant diseases to yellow mosaic virus of soybean suited in the existing cropping system. MYMV severity is gradually building up year after year and challenges to the breeders at Rampur, Chitwan.

II. MATERIAL AND METHOD

2.1 Study Area

Field experiments were conducted at Rampur, Chitwan, Nepal which is located 27° 40' N latitude, 84°19' E longitude and Altitude 228 m above sea level. The area is in rainfed bariland system with light sandy soils. The average maximum temperature is 32^{o}; the minimum is 17 ^{o} while the average temperature is 20.5 ^{o}. The area receives annual rainfall varying from 1250to 1500 mm. Long rains occur between June and August while short rains fall from September.

2.2 Field Preparation and Experimental Layout

The experiment was laid out as an augmented design. Plot sizes were fixed as 4 m by1 m in YMV observation nursery, International Soybean yield trial while 4 m by 2 m was fixed for YMV nursery. A total of fifty eight genotypes including checks in observation screening nursery, eleven in International trial and fifteen in YMV nursery were used (Table 1).The fertilizer dose was applied at the rate of recommended doses 20:40:20 kg NPK/ha. Full dose of nitrogen, phosphorous (P2O5) and potash was applied at the time of field preparation and incorporated before planting. After the application of fertilizers, soybeans seeds were planted in rows, at a spacing of 50 cm between rows and cm 10 c m within rows. Weed control was done manually by periodically scouting the plots and uprooting the weeds wherever necessary. Disease symptoms appear when the crop is about one month old. Yellow spots, usually round in shape, scattered on the lamina. Spots are diffused and rapidly expand on the leaf surface. Contrasting dark and yellowish green areas mixed with yellow spots are characteristic symptoms of the disease. Completely yellow leaves turn whitish gradually and then turn necrotic. Based on the observed symptoms, diseases scoring were done based on the 1-5 scale which was developed by IVRDC. Mungbean Yellow mosaic virus (MYMV) and Yellow mosaic virus (MYMV) and other viruses rating scale was done as 1= no virus symptoms seen, 2= occasional mild symptoms, 3= moderate infections, 4= severe and wide spread symptoms, and 5= severe with likely loss in yield. Besides Five plants per plot was tagged for recording phenological observations. The phenological data will be taken when 50% observation occurred. The phenological observations was recorded as days of flowering, days of pod setting, days of physiological maturity and yield attributing quantitative traits like grain yield, plants per unit area, plant height, pods per plant, number of branches/plant, and test weight and subjected to statistical analysis using the software Genstat Discovery Edition.

TABLE 1
SUMMARY OF EXPERIMENTAL DETAILS OF SOYBEAN (2012-2014) IN RAMPUR

Research Activities	Entry	Design	Rep	Plot size (m x m)
1.YMV observation nursery on soybean	56+ two check	Augmented	None	4 x 1
2. International Soybean yield trial	11	RCB	3	4 x 1
3. YMV nursery on soybean	15	RCB	4	4 × 2

III. RESULTS AND DISCUSSION

3.1 Yellow Mosaic Virus screening nursery on soybean, 2012/013

During 2012/013, a total of 58 soybean genotypes including standard check were evaluated at the station, Rampur. Soybean genotypes G 8754, Myagdi 1, SJ 4, 271W, LS-77-16-16, SB 0095, CN 9133, SB 0065, CM 9125 were found resistant to MYMV while AGS 874, AGS 124, CINA-2, CM 9133, Dhankuta, G- 1873, G-1946, G-8514, G-8754, IPSY178, SB00103, SB0085 and SJ4 were moderately resistant to MYMV. Standard check, Puja, was moderately resistant (Table 2).

3.2 Yellow Mosaic Virus screening nursery on soybean, 2013/14

YMV on soybean during 2013/14, a total of 48 soybean genotypes including standard check were evaluated at NGLRP, Rampur. Soybean genotypes Chaing Maw 60-63, CM 9125, PI 36859, SB 0065, SB 0095, Shinano Hiramame were found moderately resistant to yellow mosaic virus while genotypes 200525, 088 W, 093 W, 7521-26-2, AGS 367, Ankur, Dashrathpur, G 4508, G-7959, GC 8223422, Magdi-1, OCB-81, Sathiya, Tompomas were found highly susceptible to yellow mosaic virus(Table 3).

In Soybean international yield trial, 2013/14, statistically tested genotypes varied significantly on maturity days, plant height and grain yield. Check variety Puja was the highest yielder followed by TGX 1830-20E and TGX 1876-4E. Genotypes TGX 1904-2F and TGX 1925-1F produced the lowest grain yield and with poor harvest index. The early maturing genotypes were TGX 1904-4F, TGX 1835-10F and TGX 1876-4E (126 days), while Puja, TGX 1925-1F, TGX 1903-1F and TGX 1805-31F matured about 12 days later. TGX 1835-10F, TGX 1835-10F and TGX 1876-4E grew more than a meter tall, while TGX 1485-1D was comparable to Puja in plant height. Soybean genotypes TGX 1805-31F, TGX 1830-20E, TGX 1903-1F were found resistant to yellow mosaic virus and TGX 1740-2F, TGX 1835-10F, TGX 1904-2F, TGX 1904-4F, TGX 1925-1F, Puja were moderately resistant to yellow mosaic virus (Table 4).

3.3 Yellow Mosaic Virus Screening Nursery on soybean, 2014

In Rampur, genotypes varied significantly in days to maturity, plant height, pods per plant, seed size and grain yield. Soybean genotypes G-1871, F-778817, Kavre and LS-77-16-16 produced 6-20% higher grain yield than Puja. Local soybean, PK 327 and LS 77-16-16 matured in about 118 days. TGX-311-23D, G-4504, IangBeakong and G 1871 grew taller (100-135 cm). Crops took up to 147 days to mature, and plants grew taller that might have been due to early sowing time. Number of pods/plant ranged from 43-99. Seed size of IangBeakong, F-778817 and IARS-87-1 were comparable to Puja, i.e., about 10-50% larger than the rest of genotypes (Table 5). Soybean genotypes LS-77-16-16, PK327, G 1871, IangBeakong were resistant to yellow mosaic virus and Kavre, IARS-87-1, F-778817, SB0122, TGX-311-23D were moderately resistant to yellow mosaic virus out of 15 genotypes (Table 5).

IV. CONCLUSION AND RECOMMENDATION

- Soybean is susceptible to several viruses transmitted by aphids, beetles and whiteflies prevailing in Nepal. Most of the virus infection results in foliar symptoms such as mosaic and mottling, thickening/brittling of older leaves, puckering, leaf distortion, severe reduction in leaf size, and stunting of plants.
- Mungbean yellow mosaic virus transmitted by whitefly (*BemisiatabaciGennidius*) is the most prevalent virus associated with soybean mosaic disease in Nepal.
- A total of 11 to 58 different soybean genotypes including standard check were evaluated at the station, Rampur over the years.
- Mean scoring rate performances of soybean genotypes revealed that G-8754, Myagdi 1, SJ 4, 271W, LS-77-16-16, SB 0095, CN 9133, SB 0065, CM 9125, Chaing Maw 60-63, CM 9125, PI 36859, SB 0065, SB 0095, ShinanoHiramame, LS-77-16-16, PK327, G 1871, IangBeakong were found resistant to MYM.
- Further study requires to QTL analysis for identification of genetic resistance of YMV disease in molecular lab.

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